NATIONAL SHIPBUILDING
RESEARCH PROGRAM

PAINTING ON-BLOCK
THE ZONE PAINTING
METHOD ADVANTAGE

MARCH 1986

U.S. DEPARTMENT OF TRANSPORTATION
MARITIME ADMINISTRATION

IN COOPERATION WITH
AVONDALE SHIPYARDS, INC..
NEW ORLEANS, LOUISIANA

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **MAR 1996**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**
4. TITLE AND SUBTITLE **Painting on - B L O C K The Zone Painting Method Advantage**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD Code 2230-Design Integration Tower Bldg 192, Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5000**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**121**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

FOREWORD

This report is one of a series of reports 1/ dealing with the zone-oriented concept in shipbuilding, performed under the National Shipbuilding Research Program. These reports are cooperative, cost shared, efforts between the Maritime Administration (Office of Advanced Ship Development), the United States Navy and Avondale Shipyards, Inc.

The zone-oriented painting concept detailed in this and previous reports is based upon successful implementation in Japanese shipyards; in particular, Ishikawajima-Harima Industries Company, Ltd. (IHI). The logic and methods of zone-oriented painting lead to improved productivity in ship construction.

Mr. John Peart and Mr. Richard Price, on behalf of Avondale Shipyards, were the program managers responsible for technical direction and report publication. Program definition and guidance were provided by members of the Society of Naval Architects and Marine Engineers (SNAME), Ship Production Committee, Panel 023-1 (Surface Preparation and Coatings).

1/ The previous reports under this series are:

- "A Descriptive Overview of Japanese Shipbuilding Surface Preparation and Coating Methods", J. Peart and G. Soltz, National Shipbuilding Research Program; Septembe-r 1982.
- "Zone Painting Method", J. Peart and H. Kurose, National Shipbuilding Research Program, August 1983.
- "Shipyard Design and Planning for" a Zone Oriented Painting System", J. Peart and Y. Ichinose, National Shipbuilding Research Program, July 1984.

Mr. Y. Ichinose, President of IHI Marine Technology, was the project manager responsible for the coordination of the work performed by IHI. “ The research, which forms the basis of this report, was directed by Mr. Y. Okayama, IHI International, and Mr. Y. Yamamoto, IHI International, and was generated and compiled by Messrs. Y. Kido, IHI International, K. Nakagawa, IHI Kure, 1. Imada, IHI Kure, T. Hirota, I.HI Kure.

The work was edited and prepared for final copy by John Peart and Linda L. Jaekel.

EXECUTIVE SUMMARY

Ship painting is a vital part of ship construction, with the man-hours comprising about 10% of total production man-hours. With technological improvements and. increased attention on paint quality, there is a growing” painting to total production cost ratio.

The Zone Painting Method (ZPTM) has been successfully implemented in Japanese shipyards and has shown to increase both productivity and performance. This report describes the planning and methodology of zone-oriented painting, based on the research of Japanese shipyards. A special focus in this report is given to the “on-block” painting stage in ZPTM.

On-block painting is a vital element in ZPTM, adjusting, the painting work load to a more even level during the entire ship construction process. Application of shop primer and on-board painting are also treated with some detail in this report as these two elements are connected with on-block painting requirements and part of the zone-oriented painting process.

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1.0 INTRODUCTION

Under the Zone Painting Method -(ZPTM), a major advantage involves moving much of the painting requirements to the on- block stage. On-block painting involves paint application on the different zone/area/stages (defined by ZPTM planning) before the ship's blocks are erected.

The on-block concept tightens up the ship construction time by allowing painting to be done during the entire construction process, and permits a generally safer work environment than at the on-board stage (once the ship is constructed). These factors contribute to the increased productivity under ZPTM, as does the required planning under the zone-oriented concept. As different trades work simultaneously (rather than sequentially) the preliminary and detailed planning stages are very important in listing out the time and material requirements for each trade in great detail.

As on-block painting is part of a process in ZPTM, the scope of this report is to describe the methods and requirements not only for the on-block stage, but also for the related steps for painting a ship in new construction. Section 2 outlines the general concepts of the Zone Oriented Painting Method. Section 3 discusses the paint specifications and Section 4 details surface preparation methods. Using shop primer is an integral part of ZPTM and prepares the steel for both on-block and on-board painting, as discussed in Section 5. Section 6, On-Block Painting, discusses the concepts, advantages and means of implementing this method. On-Board Painting, Section

7, discusses painting of those' areas of the ship which can not or should not be painted at the on-block stage, As on-board is the final step in ZPTM, inspection criteria is also treated in Section 7.

The many charts and illustrations in this report are provided to supplement the written descriptions of concepts which can be fairly detailed.

2.0 THE ZONE ORIENTED AINTING METHOD

Paint performance can be defined as one of the most important elements affecting the ship's physical life. Ship owners are now paying more attention to the life cycle/cost of painting and ship maintenance, resulting in an increasingly higher painting to total production cost ratio. Improvements in paint performance and coating methods have been studied and implemented in Japan from a combined effort of shipyards and paint manufacturers . As a result of these efforts, the "Zone-Oriented Painting Method" (ZPTM) was established to enhance productivity and quality of painting systems.

Nowadays, most Japanese shipyards are employing ZPTM as well as the zone-oriented "Hull Block Construction Method" (HBCM) and "Zone Outfitting Method" (ZOFM), which were introduced to the U.S. shipbuilding industry through various projects of the National Shipbuilding Research Program. The following publications present detailed description of ZPTM.

- "Zone Painting Method", J. W. Peart and H. Kurose, National Shipbuilding Research Program; August 1983.
- "Product Work Breakdown Structure", L. D. Chirillo and Y. Okayama, National Shipbuilding Research Program; November 1980.
- "Shipyard Design and Planning for a Zone Oriented Painting System", J. W. Peart and Y. Ichinose, National Shipbuilding Research Program; July 1984.

The logic and principles of ZPTM follow the same logic applied in other zone-oriented construction methods such as HBCM and ZOFM. Specifically, the work units are broken down into

zone/area/stage and painting work is planned and executed by each work unit.

In ZPTM, a zone is not only defined by compartments such as decks, cargo holds, engine room, etc., but also by hull blocks, sub-blocks and components: Most important, the defined hull blocks of ZPTM are identical to the hull blocks defined for HBCM and ZOFM. Accordingly, scheduling and controlling of the on-block painting work can be planned based on the same work unit and easily integrated with HBCM and ZOFM. By applying this concept, peak work volumes can be easily leveled off. As the working units (hull block) for ZPTM are identical with those for HBCM and ZOFM, planning and control can be easily integrated with other production groups. This integration not only enhances overall ‘productivity, but also provides. similar effects on material control and accuracy control.

ZPTM changes the traditional working structure of hull construction-outfitting-painting from working in a sequence to working parallel with hull construction and outfitting.
It allows painting to be shifted from the last stage of production (on-board) to earlier stages (on-block). By doing so, the ship construction period can be drastically shortened and total man hours required for painting can be spread out over a period of time.

As on-block painting is carried out at the early stages of ship construction, it is very important to maintain the paint performance during the various stages of ship construction.

2/ The integration of Hull Construction, Outfitting and Painting (IHOP) is discussed in the publication “Integrated Hull Construction, Outfitting and Painting”, L.D. Chirillo and Y. Okayama, National Shipbuilding Research Program; May 1983.

The traditional painting process requires surface preparation by abrasive blasting on-board when the hull construction apd outfitting is almost completed. In ZPTM, full surface preparation on-block and on-board can be omitted by applying long-life exposure type shop primer before fabrication. This simplifies the work of the paint department and allows a preferred work environment for applying the shop primer as compared to blasting on-board.

The basic painting processes and stages in zone-oriented painting systems are shown in Figure 2-1. There are four main stages: shop primer coating prior to fabrication, on-block painting at the hull block assembly stage, on-board painting after erection, and touch-up stages. Touch-up coating is applied to welding joints of hull blocks, burnt areas caused by welding fittings, and damaged parts caused during construction or transportation. Each area and stage is determined during the planning phase for each ship, and is generally determined by the standard procedure of each shipyard.

Painting becomes more difficult and less productive at stages after on-block as the working environment worsens. On the other hand, painting on-block is more susceptible to repair requirements due to damage or burning from concurrent work by hull construction and outfitting. Considering these conditions, painting is planned so as to apply most of the anti-corrosive paint at the on-block stage, and apply final coating at the on-board stage.

The ratio of painting work volume, before and after launching, is approximately as follows:

“ Before launching: 70% - 80%
After launching: 20% - 302

These percentages are based upon an assumption that the deck house blocks are assembled on the ground and finished paint is

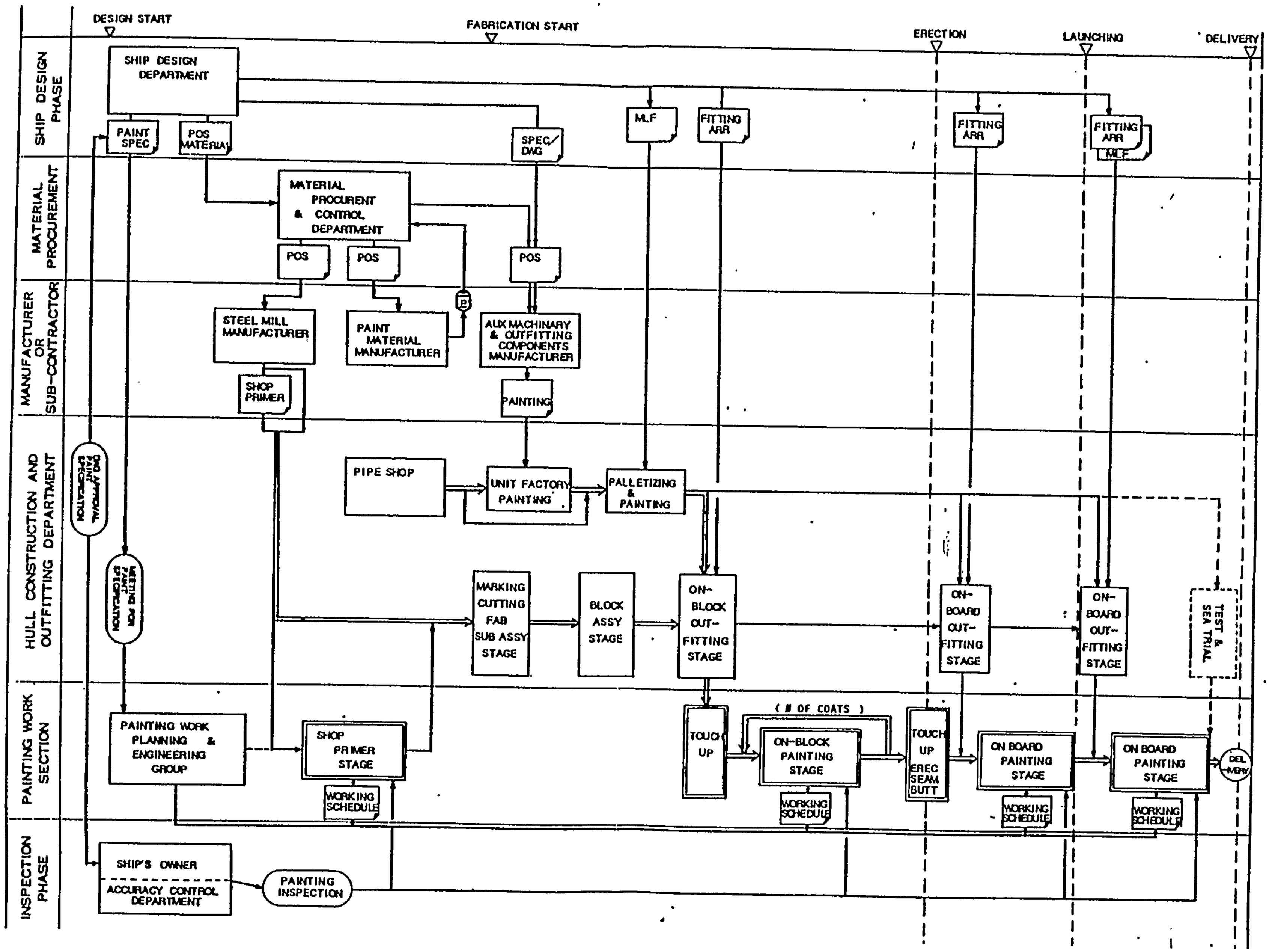


Figure 2-1: ZPTM Painting Stages

applied before erect ion-. Figure 2-2 indicates, by zone of the `ship, the different stages for surface preparation and painting from material fabrication through the final dock stages. The type of primer or paint is indicated for each coat to be applied on the different ship areas.

2.1 Implementing ZPTM

In adopting ZPTM, the following- are the prerequisites t-o successfully implement the systemi

- Detailed planning of the integrated hull construction, outfitting and painting (IHOP) and engineering schedules to correspond with the production schedule.
- Incorporate necessary measures to facilitate ZPTM in the design stage.
- Obtain consensus between engineering and production departments as well as between production shops in planning the IHOP schedule.
- Study effective working methods/processes to enhance the implementation of ZPTM, and develop suitable paint materials in cooperation with paint suppliers (i.e., long-life shop primers).
- Establish a schedule and cost-control feed-back system to further improve ZPTM.

Figure 2-3 shows the relationship and information network between the paint shop and other pertinent departments with regard to planning, scheduling, quality assurance and material procurement. The IHOP schedule is an integral part of this information network, and is given a central location in the diagram.

Figure 2-4 illustrates the painting process flow in a zone-oriented production system applied in a Japanese shipyard. For each phase of the zone oriented production, the

Painting Area		Material	Fabrication	On Block	On Board: Before Launching	On Board: After Launching	Final Dock
Shell – Bottom	Keel	Shot Blast; S/P IZP		PREP D/S; 1C TEAC, 2C VTAC, 3C VTAC, 4C SPAF, 5C SPAF, FC SPAF			Fresh Water Cleaning
Shell – Bottom	Flat			1C TEAC, 2C VTAC	3C VTAC, 4C SPAF		Fresh Water Cleaning; 5C SPAF, FC SPAF
Shell – Bottom	Except Above			1C TEAC, 2C VTAC	3C VTAC, 4C SPAF		Fresh Water Cleaning; 5C SPAF, FC SPAF
Shell	Boot Topping			1C CAC, 2C CAC	3C CBT		Fresh Water Cleaning; FC CBT
Shell	Top Side			1C CAC, 2C CAC	3C CTP		Fresh Water Cleaning; FC CTP
Exposed Deck				1C CPP		2C CPP, FC CDP	
Deck Fitting			PREP D/S; 1C CPP, 2C CPP, 3C CCP			FC CCP	
Super Structures & Deck Stores	Outside Wall			PREP D/S; 1C CPP, 2C CPP, 3C CCP		FC CCP	
Super Structures & Deck Stores	Under Insulation			1C LZ			
Super Structures & Deck Stores	Bare Steel			1C LZ, 2C WRP		FC CP	
Engine Room	Under Grating			1C BTE			
Engine Room	Engine Plate			1C LZ		2C LZ, FC DP	
Engine Room	Except Above			1C LZ, 2C WRP		FC CP	
Tanks & Void	FPT, APT WBT			1C TE			
Tanks & Void	FWT					PREP D/S; 1C EP, 2C EP, FC EP	
Tanks & Void	LOT			1C RPO			
Tanks & Void	FOT			1C RPO			
Tanks & Void	Void Space			1C BTE			
Cargo Hold	Deck Head			1C BTE			
Cargo Hold	Wall			1C BTE			
Cargo Hold	Top of Double Bottom						

BTE = Bleached Tar Epoxy Paint
CAC = Chlorinated Rubber Anti Corrosive Paint
CBT = Chlorinated Rubber Boot Top Paint
CCP = Chlorinated Rubber Finish Paint
CP = Finish Paint
CPP = Chlorinated Rubber Primer
CTP = Chlorinated Rubber Top Side Paint
DP = Deck Paint
EP = Epoxy Paint
IZP = Inorganic Zinc Primer
LZ = Lead Zinc Chromate Primer
RPO = Rust Preventive Oil
SPAF = Self Polishing Type Anti Fouling Paint
TE = Tar Epoxy Paint
TEAC = Tar Epoxy Anti Corrosive Paint
VTAC = Vinyl Tar Anti Corrosive Paint
WRP = White Rust Resisting Paint

Figure 2-2: Painting and Surface Preparation Stages by Zone

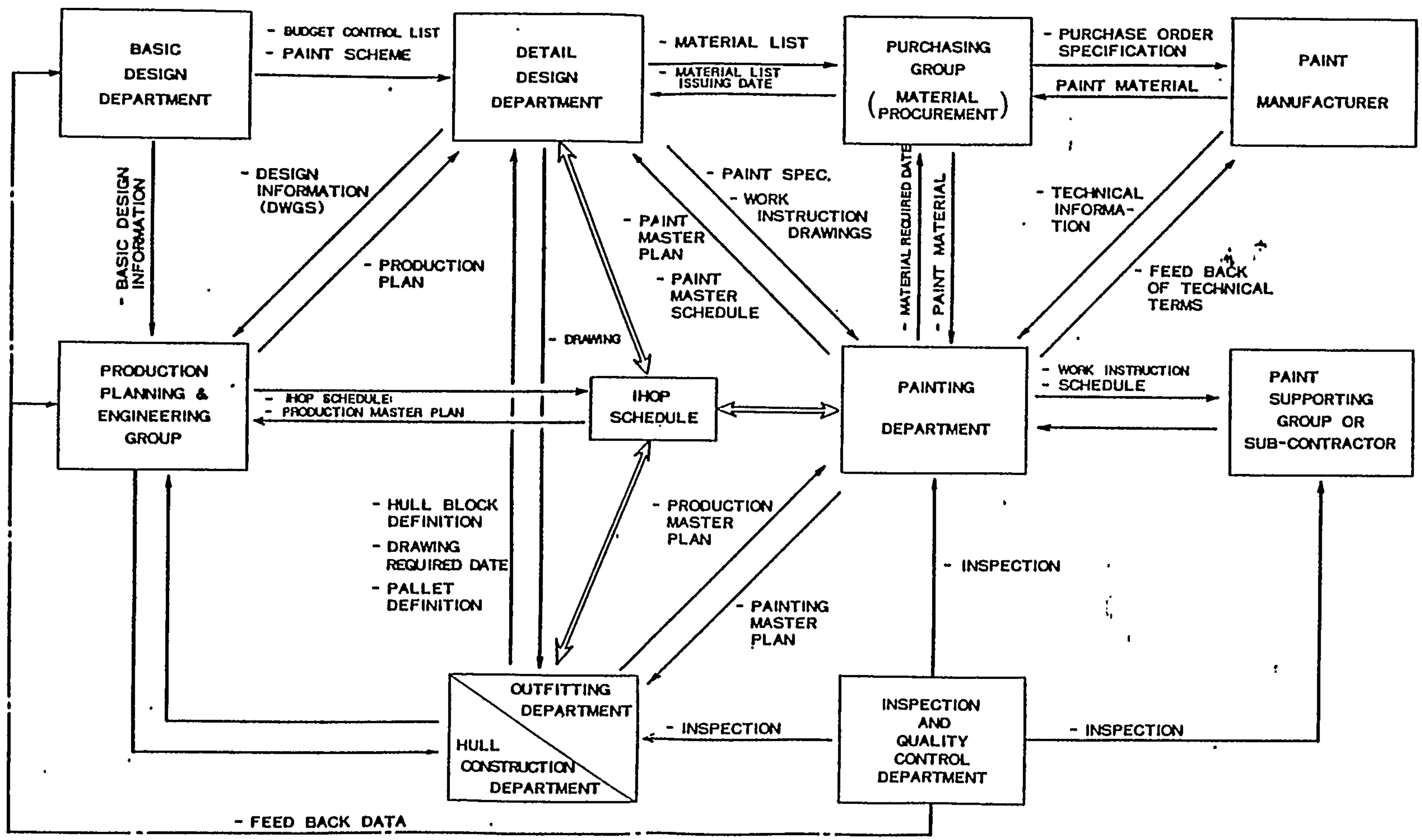


Figure 2-3: Information Network Between The Painting Department and Other Departments

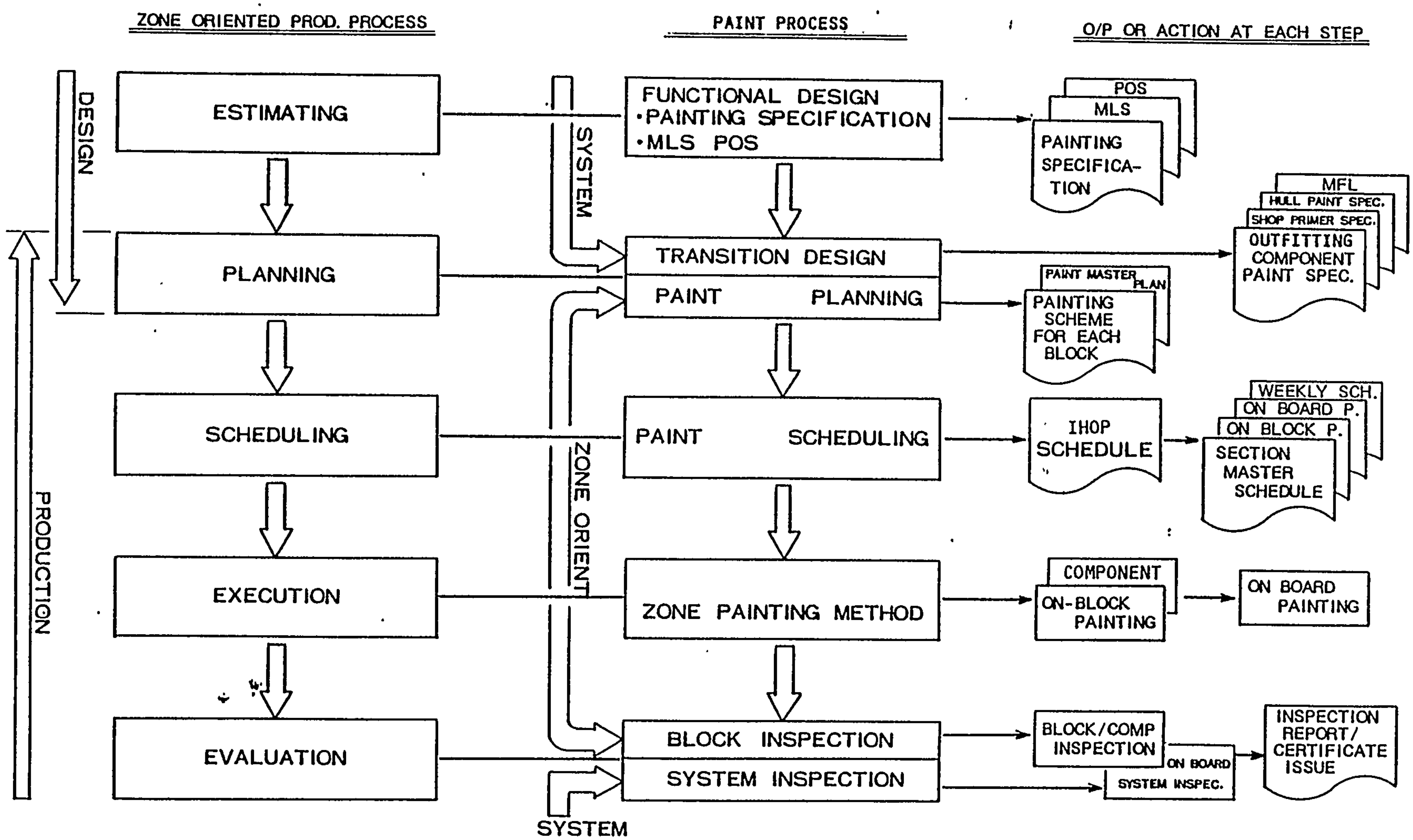


Figure 2-4: Zone-Oriented Process

more detailed action step is detailed for painting. For example, during paint planning, the paint scheme for each block is made.

Effective implementation of ZPTM will enhance paint performance. To track the paint performance of a paint system after delivery of the ship, actual paint performance data collected during several years of service should be analyzed as shown in Figures 2-5 and 2-6. - Figure 2-5 shows the ratio of the damaged surface are versus the total paint area. The ballast water tank. and the cargo hold (23% and 20% respectively) suffer the greatest damage of the different ship areas. Given these figures, great care should be taken on determining the paint for these area. Figure 2-6 gives the estimated causes of the defects. The selection of paint material shows to be the greatest cause (23%) for ensuing paint defects.

Based on these analyses, improvements in paint quality or specifications, painting processes, etc., can be derived and fed back to engineering and related production shops to further refine the ZPTM and/or paint systems.

Feed-back on the performance of the paint system (SpecificatiOns) applied is also important in establishing standard paint specifications and/or painting processes. To implement ZPTM effectively, it is essential to take the following measures:

1) Standardization of Paint Specification:
Careful selection of coating. systems as reflected in the paint specifications are most important to enhance the paint performance under the service conditions intended for a ship. Therefore, it is desirable to establish paint specifications based upon past performance records, so that appropriate

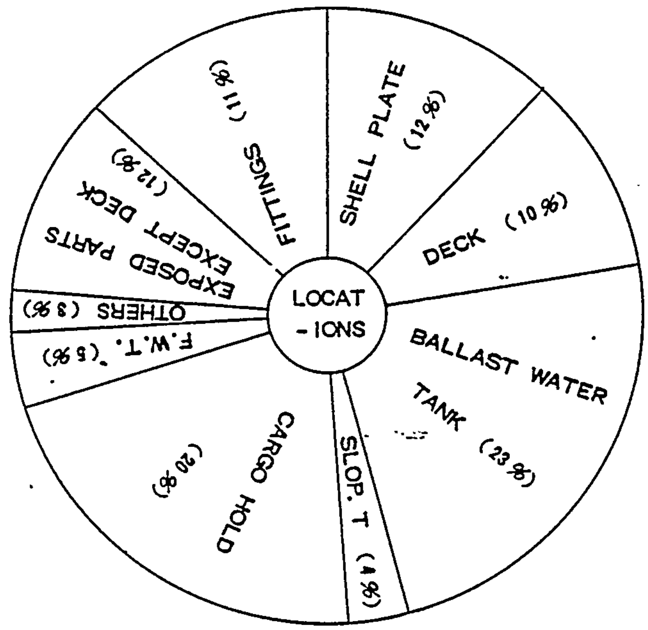


Figure 2-5: Paint Defects by Area

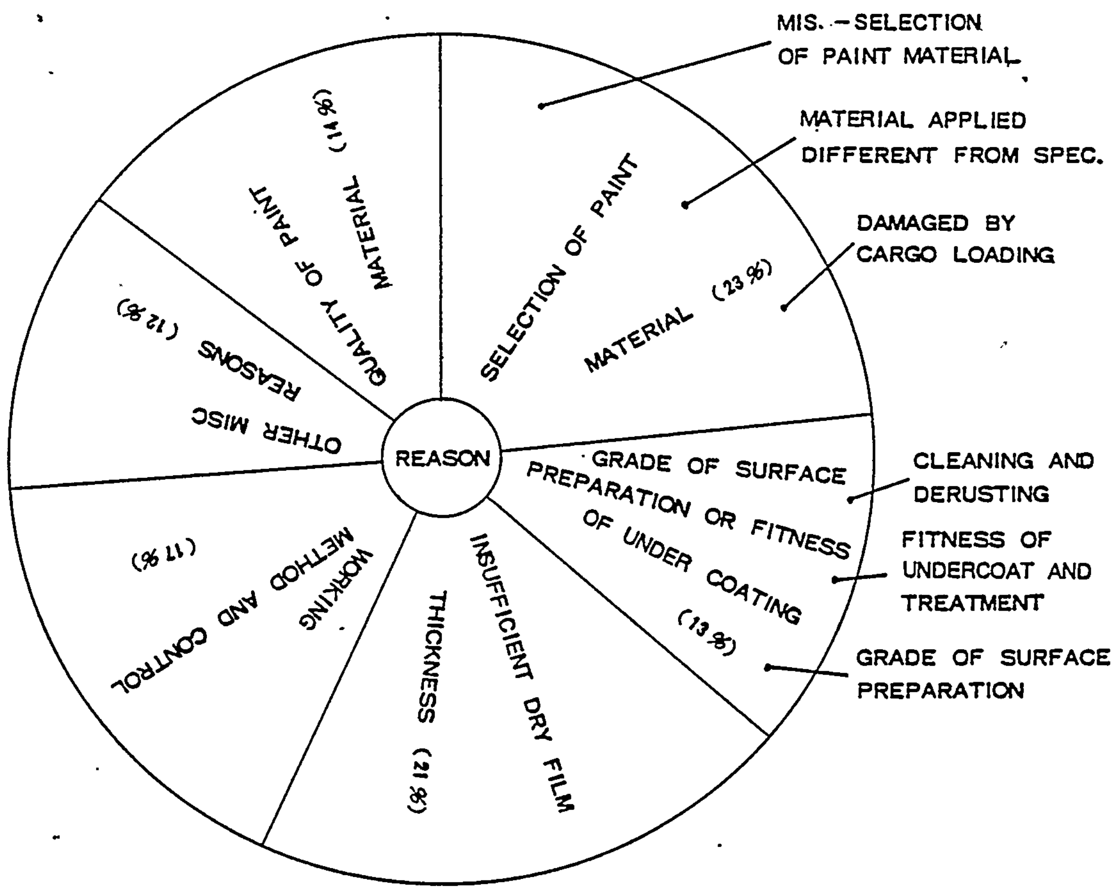


Figure 2-6: Causes of Paint Defects

paint systems and surface preparation methods can be selected to suit the service intended. In other words, by standardization, the following errors can be avoided:

- Misjudgment in selection of appropriate paint systems .
- Misjudgment as to the degree of required surface preparation for the paint system applied.

These standards should be updated as necessary based upon feed-back from ships in service, or to incorporate new paint materials developed by paint manufacturers .

Figure 2-7 is a functional flow chart of paint planning and its application process. This chart shows the different elements (paint plans, paint material" from the manufacturer) which go into the paint process, and how the information is fed back to (and is based upon prior feedback from) the shipyard standards.

2) Production and Engineering Planning for Painting:

Production planning and engineering are prerequisites for adopting ZPTM. The following items are roughly determined. at the early stages of planning.

- Definition of block arrangement (Zone).
- Painting method and its work stages (or processes) .
- Schedule of production milestones.
- Items which need further intensive study.

Painting work stages should be planned to minimize paint repair caused by hull construction and/or

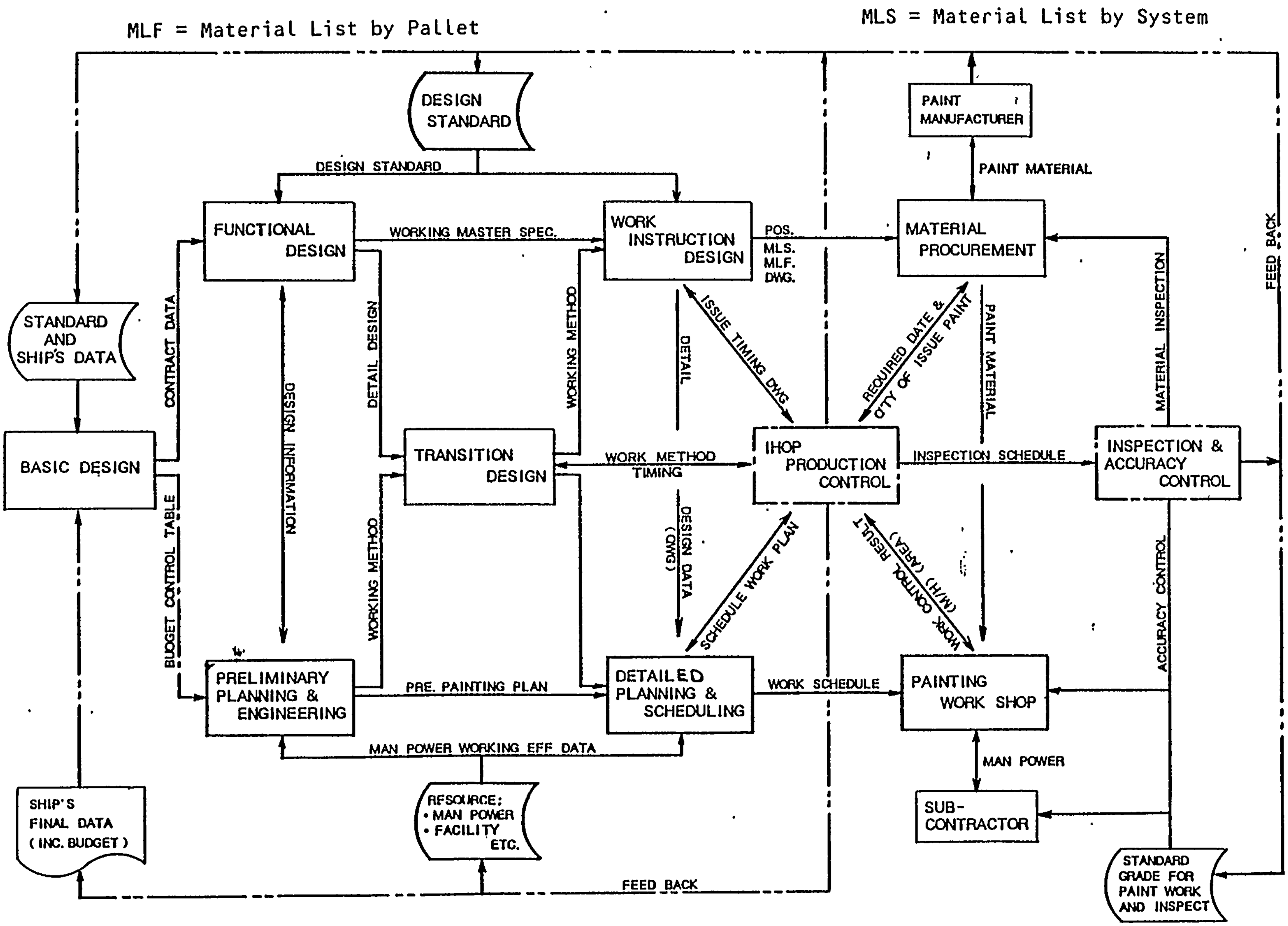


Figure 2-7: Functional Flow of Painting Work

outfitting. Figure 2-8 shows the activities of preliminary production and engineering planning. Man-hours and material required are estimated at this stage, with provisions for further refinements at later stages.

3) Planning and Execution of the Integrated Hull Construction Outfitting and Paint Schedule (IHOP):
Results of the production and engineering plannimg are finalized for each specific ship and incorporated in a detailed production schedule. The IHOP schedule is further broken down into detailed schedules, corresponding to each control level. The most important duty of the shop manager is to control and keep to the time schedule. These activities will prevent errors in:

- Timing to start and complete painting.
- Repair methods for damaged/burnt paint areas.

Figure 2-9 shows the activities in detailed planning and scheduling phases. The information from the preliminary production and engineering planning is refined, the on-board painting and on-block painting is scheduled, and the material list and issue dates are pulled together.

4) Expansion of Painting at the On-Block Stage:
On-block painting is the most effective way to improve quality and productivity of painting, as workers can do their job in safe and stable working conditions. Therefore, the work process should be planned to maximize on-block painting and minimize on-board painting.
By doing so, the following defects can be minimized:

- Poor workmanship due to unstable work conditions.

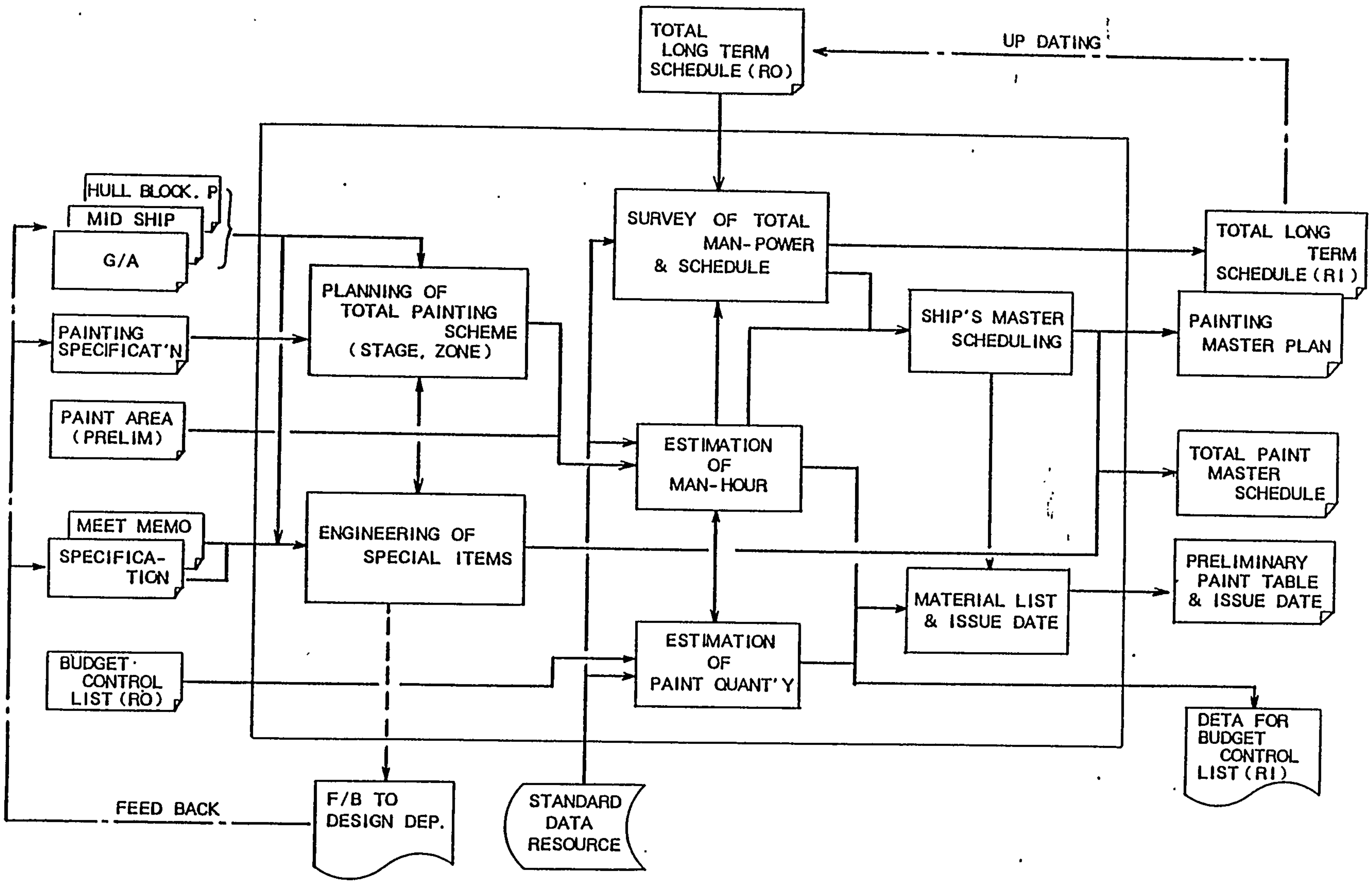


Figure 2-8: Relation Between Preliminary Planning & Engineering

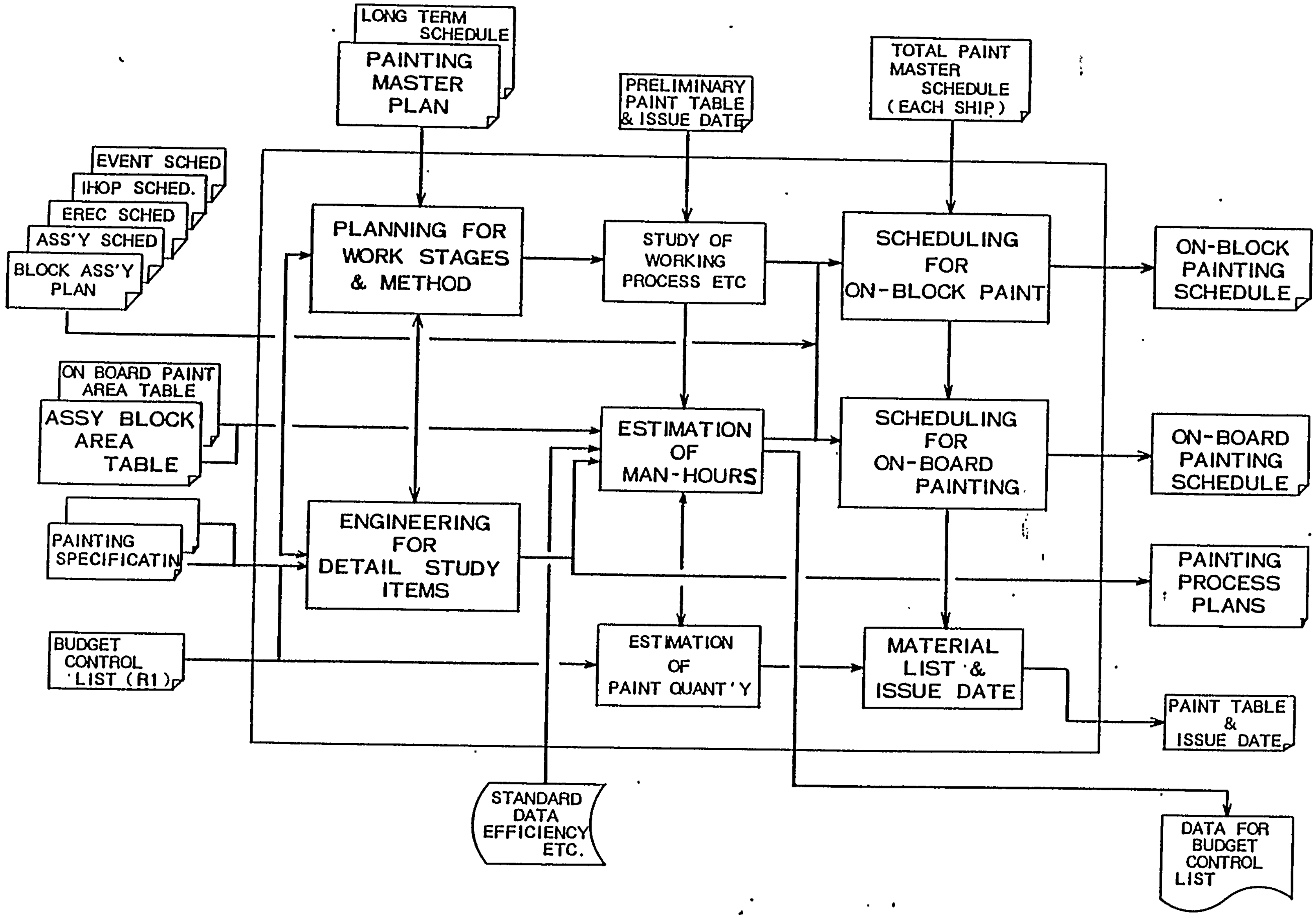


Figure 2-9: Relation Between Detailed Planning & Scheduling for Painting

- Uneven dry film thickness.
- Insufficient surface preparation.

As ZPTM evolved from the logic and principles of HBCM and ZOFM, it brings the following advantages:

- Integration of hull construction, out fitting and painting schedules (IHOP-Schedule).
- Shorter construction periods.
- Adjusted work loads from peak periods to more even requirements during construction.
- Preferred work environment in shop primer application versus blasting on board.
- Improvement in paint performance.

As mentioned in previous sections and other National Shipbuilding Research Program publications, it is quite clear that paint performance can be enhanced without reducing work productivity by adopting the on-block painting system. This painting method has also resulted in upgrading the paint performance.

Figure 2-1o illustrates the relationship between paint performance, control factors and work efficiency. This figure shows individual elements of the process which affect either the paint performance or the work efficiency of painting, Such elements are described in frames representing "paint performance" and "work efficiency", respectively. Some are common elements of both paint performance and work efficiency, and are the key elements to improve both of the above two. Accordingly, special attention is paid to these common elements in determining the work stages and work methods.

Work efficiency can be significantly improved by shifting-on-board painting to on-block painting and by improving the working environment.. Further improvement "can be achieved by

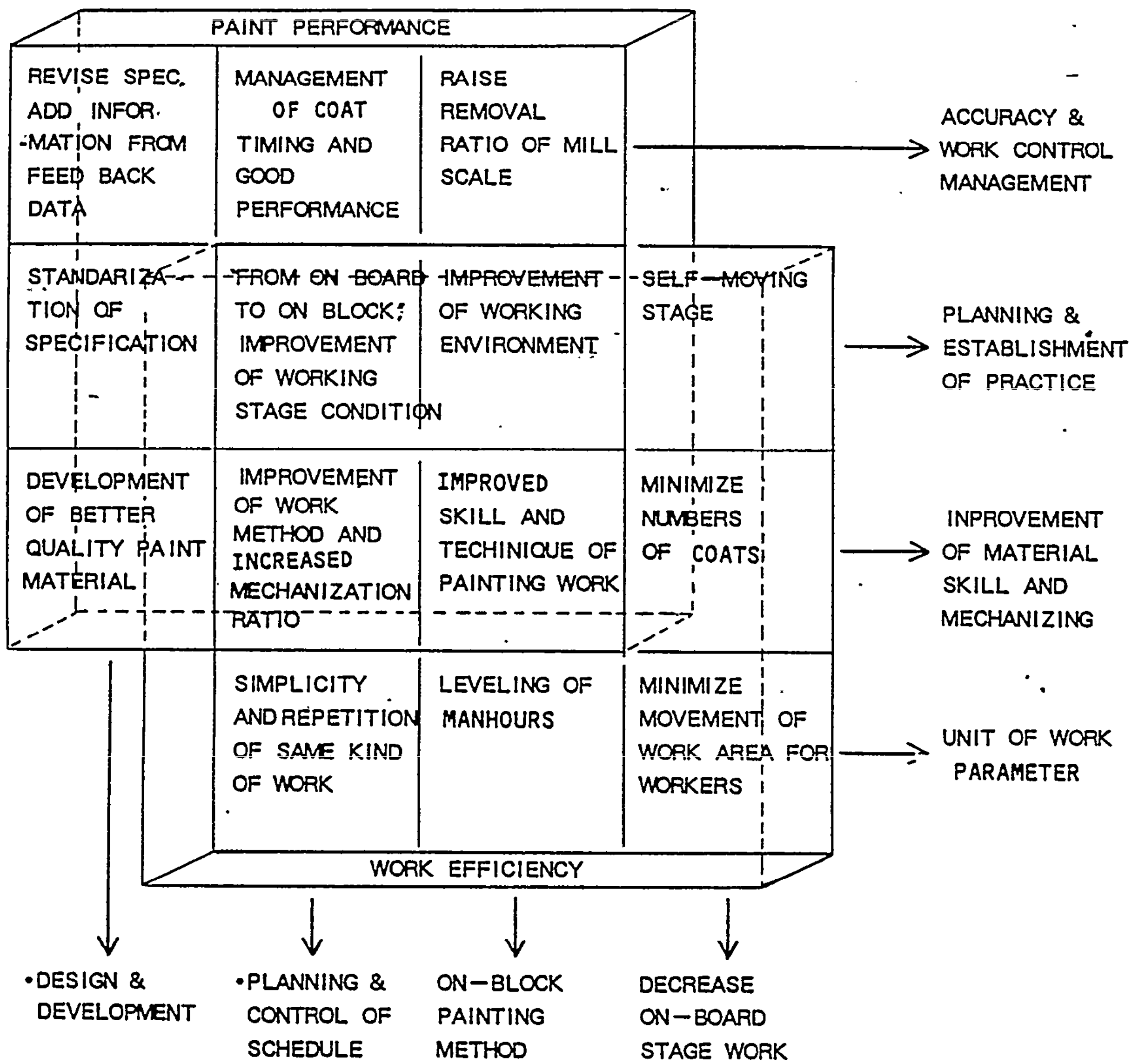


Figure 2-10: Relationship Between Paint Performance, Control Factors and Work Efficiency

introducing automation and/or mechanization (such as robots) into the painting process, but this requires time and money.

Based on these considerations, the following are suggestions to enhance paint performance and work efficiency:

1) Adopting the On-Block System:
The adoption of the on-block painting system is the best way to attain good paint performance as well as high productivity. However, the following are some of the prerequisites that should be satisfied prior to applying this method:

- Durability of shop primer coating:
The main objective of shop primer coating is to protect the steel surface from rusting during fabrication and assembly of hull units, until it receives the first coat of the specified paint. Therefore, the shop primer material must have the durability to preserve the anti-corrosion capability during this period. Otherwise, no benefit is obtained by adopting the on-block. painting system.
- Application of on-block outfitting:
The application of on-block outfitting is a prerequisite for on-block painting since the objective of on-block painting is to minimize repair of paint damage, and to minimize the movement of workers from one paint area to another. Therefore, outfitting work should be finished as far as possible before painting to prevent damage to the coating.

2) Establishing an Integrated Scheduling System:
Determination of work sequence and timing is the most important factor in painting, to assure the paint performance and to enhance productivity.

Accordingly, close coordination is essential between production shops, not only to paint, but also for other production processes. Establishment of an integrated hull construction, outfitting and painting schedule (IHOP Schedule) is the most effective way to operate the total zone-oriented production system. To establish an IHOP schedule, the following process is suggested:

- A planning and engineering group, including painting and other production engineers, should be organized.
- Classify painting parameters by zone, area and stage to facilitate palletizing and the parameters for cost estimation and control.

3) Standardization of Work Practices:
Standardization of work practices is an effective means to maintain a uniform quality and workmanship as well as personal skill, and makes it easier to plan and control the paint schedules. The following should be standardized.

- Work processes and methods at each stage.
- Inspection procedures and quality assurance.
- Painting specifications, including surface preparation.

The zone oriented painting method incorporates many factors which lead to improved paint performance, Determining the appropriate paint specifications, which incorporate surface preparation methods, is vital to the whole zone oriented concept. Section 3 discusses paint specifications in more detail, and Section 4 goes into depth on surface preparation.

3.0 PAINT SPECIFICATIONS

Determination of paint specifications at the design phase is a vital factor in insuring paint performance. It is best to determine the paint specifications based on a predetermined standard specification which will suit the ship's type and service, and then make necessary modifications to meet specific requirements of the cargo, voyage conditions, and any other particular service conditions. The final paint specifications should be agreed to by the ship's owner.

Figure 3-1, Determining Paint Specifications, shows the coordination` required in the development of paint specifications between the paint design group, the "planning engineering group, the paint shop, and the ship's owner. The developed paint plan includes the following:

- Method and grade of surface preparation.
- Number of coats to apply and the paint colors.
- Method and frequency to inspect dry film thickness.
- List of manufacturer's products which meet the specifications.

Appendix A classifies different kinds of marine paints according to their generic type (i.e. epoxy resin) and includes both shop primers and overcoat paints. The composition of each type is provided, along with the. common usage per ship area.

Appendix. B lists various paint products according to type of paint, color and dry film thickness. Name brands are indicated from three Japanese paint manufacturers.

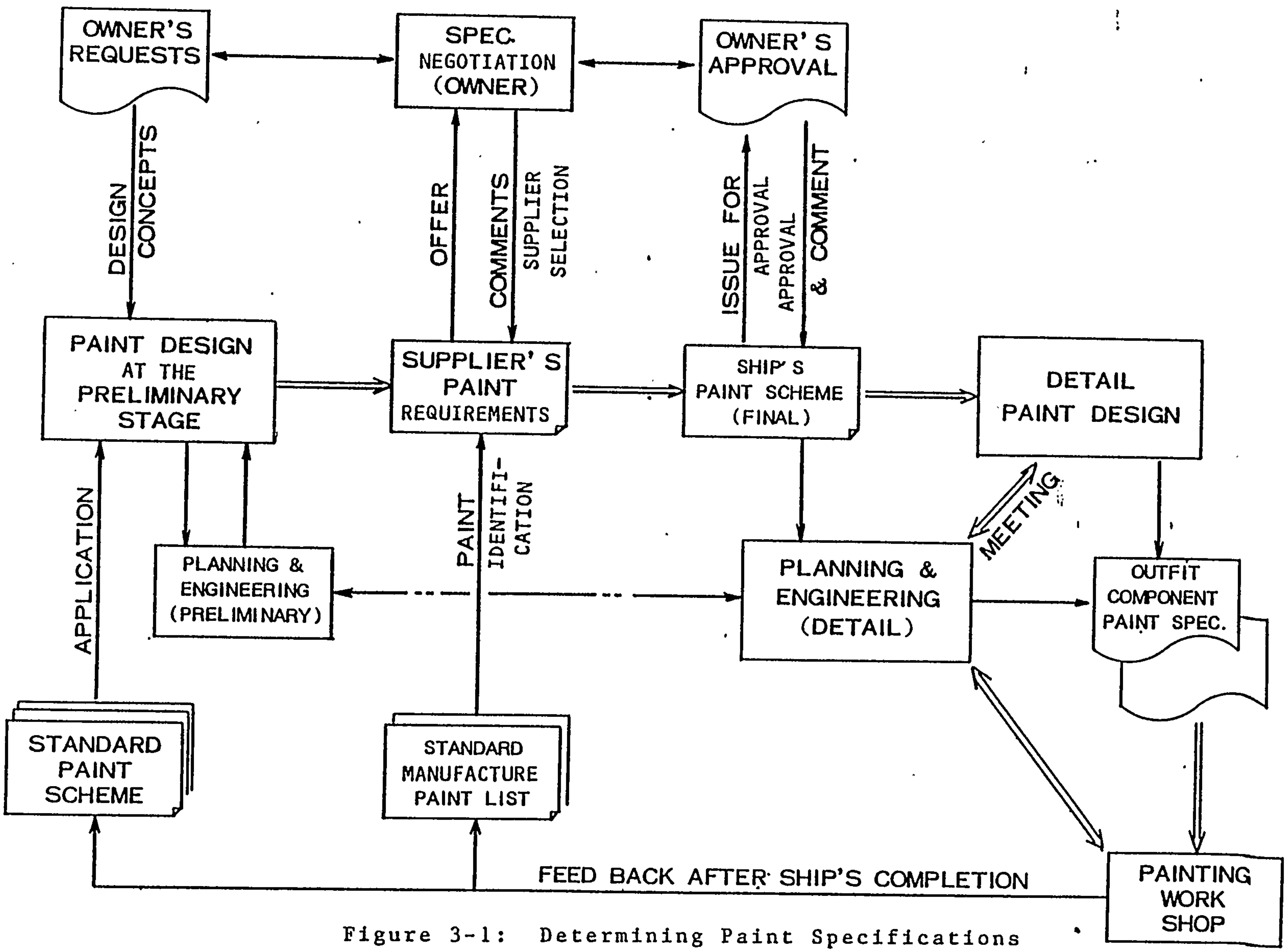


Figure 3-1: Determining Paint Specifications

There exist several standards which specify the grade of surface preparation. The two major standards applied throughout the world are the Steel Structures Painting Council "Surface Preparation Standards" (SSPC) and the Swedish Standards Institution "Pictorial Surface Preparation Standards for Painting Steel Surfaces" (S1S).

The SSPC standards define levels of surface cleanliness on both new and aged steel and the methods of cleaning are identified according to abrasives and type of equipment. The S1S Standards are visuals defining primary surface preparation for new steel.

The Shipbuilding Research Association of Japan has developed the "Standard for the Preparation of Steel Surface Prior to Painting" (JSRA), a visual standard defining levels of cleanliness for both primary and secondary preparation of, new steel. Shipyard practice tends to refine the standard used to its own circumstances. Both primary and secondary levels of surface preparation are applied in ZPTM. Primary surface preparation (automatic shot blasting is the general practice applied in Japanese shipyards) is carried out to remove rust and mill scale from the steel surface before applying shop primer. Shop primer protects the steel from rusting during the fabrication and assembly stages. This treatment has become more important in adopting HCBM, which requires a higher grade of protection. Figure 3-2 is an example of a standard surface preparation specification before applying coatings on a ship under construction.

Secondary surface preparation is carried out to treat the steel surface before applying the first coat and/or following coats. The treatment grade determined depends on the kind of shop primer applied.

SYMBOL OF SURFACE PREPARATION GRADE	(ISP-A)		(ISP-B)	
TREATMENT	STEEL SHOT BLAST CLEANING	ABRASIVE BLAST CLEANING	SHOT BLAST CLEANING	PICKLING
PHOTOGRAPHIC STANDARD FOR SURFACE GRADE	JSRA 1	JSRA 2	JSRA 3	JSRA 4
	SIS SA 2 1/2		SIS SA 2	
APPLICATION	WHERE INORGANIC ZINC SHOP PRIMER ARE USED, OR WHERE EPOXY RESIN PAINTS ARE APPLIED IN C.O.T., B.W.T., F.W.T. AND THE EXTERNAL HULL		WHERE ORGANIC SHOP PRIMER OR EPOXY RESIN PAINTS ARE APPLIED TO AREAS. OTHER THAN C.O.T., B.W.T., F.W.T. AND THE EXTERNAL HULL, OR WHERE CONVENTIONAL PAINTS, SUCH AS OLEORESINOUS SYNTHETIC PAINTS, CHLORINATED RUBBER PAINTS, ETC. ARE APPLIED.	

NOTE:

1. THE EXTERNAL HULL MEANS OUTSIDE OF SHELL, WEATHER EXPOSED PART OF DECKS AND SUPERSTRUCTURES.
2. EPOXY RESIN PAINT MEANS EPOXY PAINT, TAR EPOXY PAINT AND BLEACHED TAR EPOXY PAINT.
3. COPPER SLAG IS USED AS ABRASIVE MATERIAL-FOR BLAST CLEANING.

ISRA = Shipbuilding Research Association of Japan (standards)
SIS = Swedish Standards Institution (standards)

Figure 3-2: Primary Surface Preparation Specification

Before applying shop primer or other oats, the surface condition should be checked and cleaned to meet the required level of cleanliness. If the surface is not clean, it can lead to poor adhesion of the paint and, eventually, poor performance during the ship's service. Figure 3-3 specifies the grade of surface cleaning according to the different paints to be applied on the steel.

3.1 Paint Selection

The paint selection is based upon the following factors:

- Relationship between the paint area and the functional characteristics of the paint material. This is depicted in Figure 3-4, which shows the various paint properties required for different ship areas. These requirements determine the selection of paint.
- Compatibility of the shop primer with the overcoat paints. Figure 3-5 measures 6 performance factors for 4 different types of shop primers and Figure 3-6 compares the compatibility of these 4 shops primer with 6 different types of paint systems. Suitable shop primers and paint systems are written into the paint specifications and redefined while preparing the paint plan.
- Compatibility with the production method.
- Coating life data incorporated from past ship construction.

An example of a painting scheme on a tanker is shown in Figure 3-7. The paint specifications are included for the type of paint, number of coats to be applied and dry film thickness. It also lists, for both primary and secondary surface preparation requirements, the means of cleaning and shop primer to be used. All these requirements are detailed according to the areas of the ship.

ITEM \ PAINTS	INORGANIC ZINC PRIMER OR EPOXY PAINT (C.O.T FOR PETRO PRODUCTS)	EPOXY RESIN PAINT	CONVENTIONAL PAINT, SUCH AS OLEORESINEOUS SYNTHETIC PAINT, CHLORINATED RUBBER PAINT, ETC.
WATER AND SALT	CANNOT BE SEEN VISUALLY		
FATS AND OILS	SHOULD BE COMPLETELY REMOVED	SHOULD BE REMOVED, BUT TRACES MAY REMAIN	
SOAP SOLUTION	CANNOT BE SEEN VISUALLY		
WHITE DEPOSITS (ZINC SALTS)	EXCESS TO BE WIPED OFF BY DRY CLEAN CLOTH OR LIGHT SANDING		
CHALK MARKS	TO BE WIPED OFF BY A CLOTH WITH SOLVENT		TO BE WIPED OFF BY DRY CLOTH
MARKING PAINTS	MARKING PAINTS FOR EPOXY RESIN, COATING; SHOULD NOT BE REMOVED. IN OTHER CASES REMOVE BY DISC SANDER, ETC. SLIGHT TRACES MAY REMAIN.		SHOULD NOT BE REMOVED
OTHER FOREIGN MATTER	TO BE WIPED OFF BY A CLEAN CLOTH, BUT TRACES MAY REMAIN		
DAMAGED PAINT FILM	DAMAGE OR INCOMPLETE PAINT FILM CAUSED BY WELDING, BLISTERING, ETC. MUST BE REPAIRED		
NOTE: BARNACLES, SEA WEEDS, FATS, OILS, SLIME, ETC., SHOULD BE REMOVED AT DRY DOCKING, BUT SLIGHT TRACES MAY REMAIN			

Figure 3-3: Sample Grade of Surface Cleaning

Paint Area		Anti-Rusting	Water Resistance	Weather Resistance	Impact Resistance	Soil and Contamination Resistance	Fouling Resistance	Abrasion Resistance	Oil Resistance	Gloss Retention and Chalking Resistance
SHELL	BOTTOM	○	○			○	○			
SHELL	BOOT-TOPPING	○	○	○	○	○				○
SHELL	TOP SIDE	○	○	○	○					○
EXTERIOR STRUCTURE	DECK	○	○	○				○		○
EXTERIOR STRUCTURE	SUPER STRUCTURE	○	○	○						○
EXTERIOR STRUCTURE	UNDER DECK COVERING	○								
EXTERIOR STRUCTURE	UNDER DECK MACHINERY	○	○	○					○	
EXTERIOR STRUCTURE	DECK FITTINGS	○	○	○						○
INTERIOR STRUCTURE	ACCOMODATION SPACE & STORE	○								○
INTERIOR STRUCTURE	ENGINE ROOM	○								○
CARGO HOLD (DRY)		○			○			○		
TANK INTERIOR	FW, DR. W, DIST. W	○	○							
TANK INTERIOR	CARGO OIL	○								
TANK INTERIOR	WATER BALLAST	○	○							
TANK INTERIOR	FUEL OIL									
TANK INTERIOR	LUB, OIL									
VOID SPACE		○								

Figure 3-4: Paint Properties Required by Ship Area

TYPE OF SHOP PRIMER \ PERFORMANCE	EASE OF PAINTING WORK	ADHESION	WEATHER RESISTANCE	ABRASION RESISTANCE	GOOD CUTTING AND WELDING CHARACTERISTICS	RESISTANCE AGAINST DAMAGE
LONG EXPOSURE TYPE WASH PRIMER	○	○	△	△	○	△
ZINC EPOXY PRIMER	△	△	○	○	△	○
NON ZINC EPOXY PRIMER	○	○	○	○	△	△
INORGANIC ZINC SILICATE PRIMER	△	○	○	○	△	○

○ = SUITABLE
△ = ATTENTION REQUIRED IN APPLICATION
× = NOT SUITABLE

Figure 3-5: Performance of Shop Primers

TYPE OF SHOP PRIMER \ OVERCOAT PAINT	OIL PAINT	CHLORINATED RUBBER	VINYL	TAR-EPOXY	PURE-EPOXY	INORG. ZINC
LONG EXPOSURE TYPE WASH PRIMER	○	○	○	○	△	×
ZINC EPOXY PRIMER	○	○	○	○	○	×
NON ZINC EPOXY PRIMER	△	○	○	○	○	×
INORGANIC ZINC SILICATE PRIMER	×	△	○	○	○	○

○ = SUITABLE
△ = ATTENTION REQUIRED IN APPLICATION, SUCH AS COMPATIBILITY, ETC.
× = NOT SUITABLE

Figure 3-6: Compatibility Between Shop Primers and Paint Syst

PAINT AREA		PAINT SPECIFICATION: KIND OF PAINT & NOS OF COAT	DRY FILM THICKNESS (μ)	PRIMARY SURFACE PREPARATION: TREATMENT	PRIMARY SURFACE PREPARATION: SHOP PRIMER	SECONDARY SURFACE PREPARATION: TREATMENT	SECONDARY SURFACE PREPARATION: RECOATING OF SHOP PRIMER
SHELL	BOTTOM SHELL	CHLORINATED RUBBER BOTTOM PAINT-A×2 CHLORINATED RUBBER BOTTOM PAINT-B×2	140 80	SHOT BLAST	WASH PRIMER ZINC EPOXY PRIMER NON ZINC PRIMER	POWER TOOL	NECESSARY
SHELL	BOOT TOP SHELL	CHLORINATED RUBBER BOTTOM PAINT-A×2 CHLORINATED RUBBER BOOT-TOP PAINT×2	140 60	〃	〃	〃	〃
SHELL	TOP SIDE SHELL	CHLORINATED RUBBER BOTTOM PAINT-A×2 CHLORINATED RUBBER TOP SIDE PAINT×2	140 60	〃	〃	〃	NOT NECESSARY
EXPOSED AREA	DECK	CHLORINATED RUBBER ANTI-CORROSIVE P×2 CHLOR RUB DK P×1	70 35	〃	〃	〃	〃
EXPOSED AREA	SUPER STRUCTURE	CHLORINATED RUBBER ANTI-CORROSIVE P×2 CHLOR RUB FINISH P×2	70 60	〃	〃	〃	〃
ENGINE RM	TANK TOP	TAR EPOXY PAINT ×1	100	〃	〃	〃	〃
ENGINE RM	OTHER AREA	ANTI-CORROSIVE OIL PAINT ×2 FINISHED OIL PAINT×1	70 35	〃	〃	〃	〃
PUMP RM	BOTTOM PART	TAR EPOXY PAINT ×1	100	〃	〃	〃	〃
PUMP RM	OTHER AREA	ANTI-CORROSIVE OIL PAINT ×2 FINISHED OIL PAINT×1	70 35	〃	〃	〃	〃
INTERNAL AREA OF SUP S	UNSHEATHED STEEL SURFACE	ANTI-CORROSIVE OIL PAINT ×2 FINISHED OIL PAINT×1	70 35	〃	〃	〃	〃
INTERNAL AREA OF SUP S	HIDDEN STEEL SURFACE	ANTI-CORROSIVE OIL PAINT ×2	70	〃	〃	〃	〃
TANKS	CARGO OIL TANK	NO PAINTING	—	—	—	—	—
TANKS	BALLAST W TANK	TAR EPOXY PAINT ×1	250	SHOT BLAST		POWER TOOL	NOT NECESSARY
TANKS	CARGO/BALLAST TANK	TAR EPOXY PAINT ×1	250	〃	WASH PRIMER ZINC EPOXY PRIMER NON ZINC PRIMER	〃	〃
TANKS	FUEL OIL TANK	NO PAINTING	—	〃		ROUGH CLEANING	—
TANKS	FRESH WATER TANK	EPOXY PAINT×2	150	〃		POWER TOOL	〃
TANKS	COFFERDAM & VOID SPACE	ANTI-CORROSIVE OIL PAINT ×2	70	〃		〃	〃

Figure 3-7: Standard Specification and Paint Scheme (Tanker)

(Taken from "Basic Expertise of Design for Merchant Ship", IHI)

Appendix C provides an even more extensive sample paint scheme for a bulk carrier. The ship areas are further broken down and the grade of surface preparation is indicated.

The surface preparation grade and tools utilized are indicated in the paint specifications. Section 4 describes ”some of the elements of surface preparation in more detail; in particular, the various methods of cleaning the steel.

4.0 SURFACE PREPARATION

Surface preparation, as defined here, means to remove millscale and rust on the steel surface, and to remove water: oil and other miscellaneous dirt on the steel and/or coating surface to ensure adhesion and build an effective paint film.

Regarding paint performance it is generally said that insufficient surface treatment is the cause of more than 50 percent of the paint failures experienced. In general, painting has two functions. One is to protect the steel surface from corrosion, and the other is to give a good cosmetic appearance. In shipbuilding, special attention is paid to the paint’s anti-corrosive capability, because it affects the ship’s life and service performance. Unless the surface treatment is properly carried out, the following failures would occur even though a high quality paint is used.

- If the shop primer is applied over rust or dirt, the film’s thickness and its adhesion will be reduced, resulting in early paint failure.
- If the first and succeeding overcoats are painted on. a surface with residuals of moisture or water, oil and/or other miscellaneous dirt, serious defects such as lifting or blistering of the coating will occur.

It should be noted that, in addition to the surface preparation grade, the roughness of the blasting surface (anchor pattern) also affects the paint” performance. For example, too high a profile may result in pinpoint rust and one too low may cause poor adhesion of the coating.

As paint performance is affected by the grade of surface preparation, the grade of surface preparation is affected by the air pressure used in blasting. Figure 4-1 shows the relative percentage of the causes of defects on film performance from blast pressure, nozzle speed, and other factors of the blasting process. ”

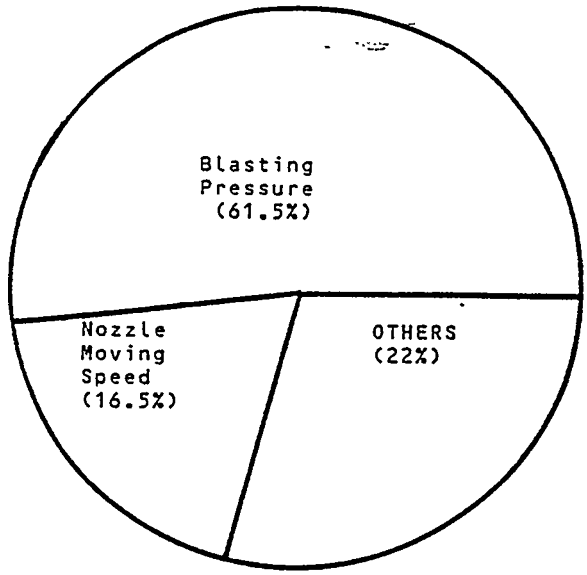


Figure:4-1 Causes of Surface Preparation Defects From Sand Blasting
(Taken from “Kogyo To So No. 5“)

Figure 4-2 depicts the effect of the surface preparation grade on the paint performance. One figure shows that, i= salt water immersion, about 90% of the failures are caused by improper surface treatment; the other figure shows that the coating life of chlorinated rubber paint depends upon the amount of millscale remaining after cleaning (i.e., the surface preparation grade). It indicates that the surface preparation grade should be at least St 2.5 of the Swedish

standard to maintain good performance. These figures relate to the eventual performance of chlorinated rubber paint in salt water immersion.

o Causes of paint Performance Defects of Chlorinated Rubber Paint in Sea Water

o Performance of Chlorinated Rubber Paint Relative to the Grade of Surface Preparation

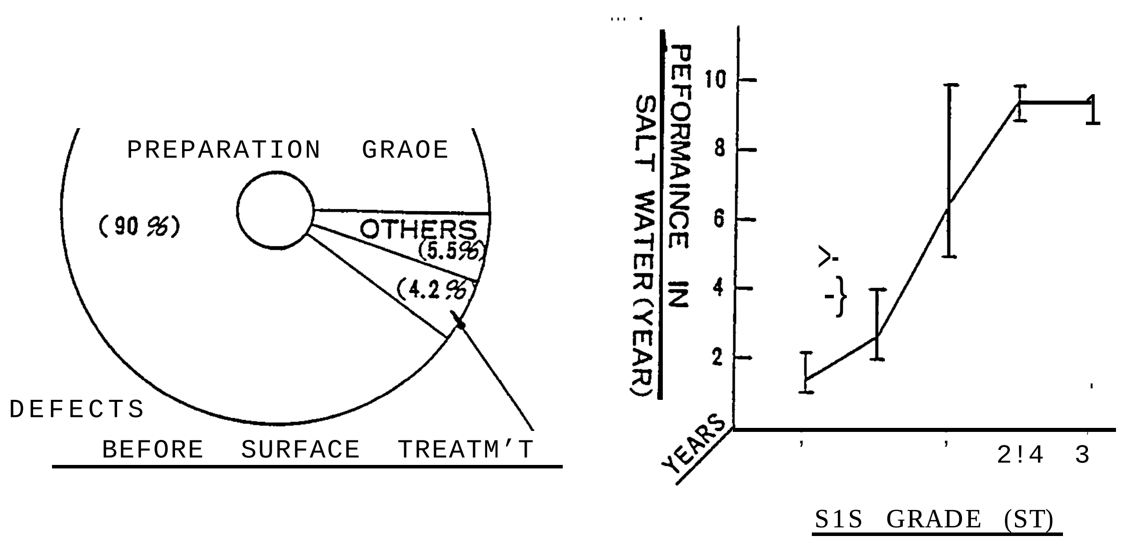
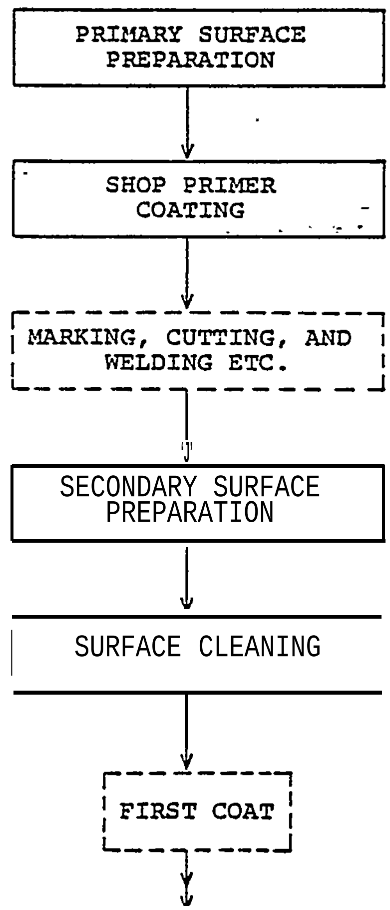


Figure 4-2: Chlorinated Rubber Paint Performance in Sea Water

(Taken from "Kogyo Toso No. 5")

Surface preparation consists of three stages; the primary, secondary and cleaning stages, as in the following diagram. In Japanese shipyards, primary surface preparation occupies about 90% of the total surface treatment work and is generally done by automatic shot blasting. Other methods, such as pickling, sand blasting and grit blasting are also utilized, depending upon the material cleaned. Power tools such as a

power brush, disc sander, etc., are mainly applied in secondary preparation.



Various surface preparation methods used for primary surface preparation. are shown in Figure 4-3, with its priority order for application on different steel materials. The roughness and surface preparation grade for each method of surface preparation is shown in Figure 4-4. Different methods are discussed below.

4.1 Methods of Surface Preparation

1) Automatic Shot Blasting:
Blasting material such as steel shot, steel grit,

KINDS OF MATERIALS	METHODS OF SURFACE PREPARATIONS			
	AUTOMATIC BLASTING	SAND BLASTING	GRIT BLASTING	PICKLING
STEEL PLATE	1	—	—	—
SHAPE	1	2	3	4
STEEL PIPE	—	2	3	1
FORGED STEEL	3	1	2	—
NOTES	1) NUMERIC NUMBER IN ○ MARKS, SHOWS THE PRIORITY FOR APPLICATION. 2) — MARK IS NOT APPLICABLE.			

Figure 4-3: Application of Surface Preparation Methods

METHODS \ APPLICATION	MAXIMUM ROUGHNESS (MICRONS)	S I S GRADE	SURFACE PREPARATIONS	
			PRIMARY	SECONDARY
GRIT BLASTING	100 (4mils)		○	
SHOT BLASTING	70 (Approx. 3mils)	BSa 2½	◎	
SAND BLASTING	40		○	○
POWER BRUSHING	5	CSt3, BSt3		○
DISC SANDER	15	CSt3, BSt3		○
ACID PICKLING	10		○	

Figure 4-4: Roughness and Grades by Method of Preparation

cut wire, tc., are impacted on the steel surface through impellers of a high velocity centrifugal wheels. Millscale and rust are removed by the energy imparted by the impact of the blasting material. The grade of derusting is controlled by the following conditions anil formula:

- Moving speed of the steel material.
- Size and hardness of the blasting material.
- Shot velocity.
- Volume of blasting material per unit area.

$$Q = \frac{n.g.}{2.b.v.}$$

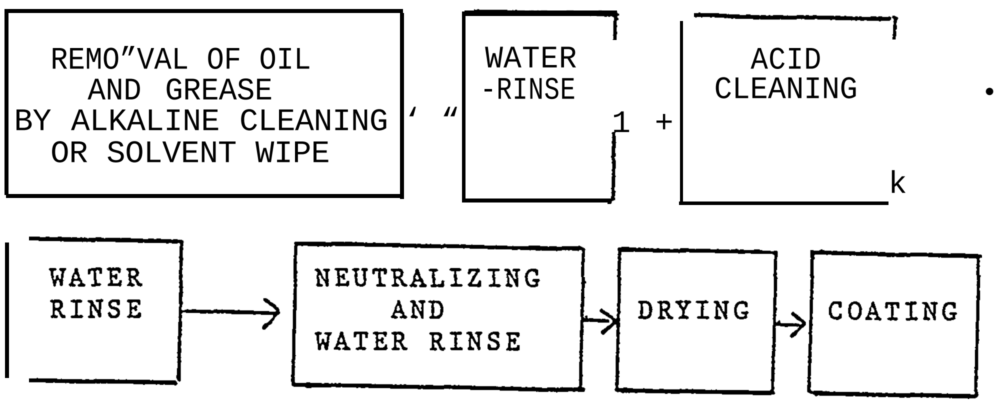
where;
Q: Shot volume per area (kg/m2)
g: Ejected volume per impeller (kg/min.)
n: Number of impellers
b: Breadth of steel material (meter)
v: Moving speed of steel material (m/min.)

2) Sand Blasting and Grit Blasting:

In these methods, the abrasive material is propelled through a nozzle at high velocity by means of compressed air. The abrasives used for sand blasting are hard, multi-angular sand which must be clean and dry. The blasting machine is portable and can be moved to the work site. The workers must be wearing airfed masks to protect them from the dust generated by the blasting.

Nickel or copper stages are generally used for grit blasting. The process is similar to sand blasting, but this method is normally used inside a closed blast facility. An anchor pattern is created on the steel” surface by these blasting methods, and it is ideal for paint adhesion. These blasting methods are usually employed for high grade coating, such as epoxy coatings of cargo and ballast tanks.

Pickling (Chemical Surface Preparation):
By pickling, millscale and other foreign material is removed by the chemical reaction of acids such as hydrochloric, sulfuric or phosphoric acids. The normal pickling process is shown below.



Immersion temperature and times are determined depending upon the kind of material and its thickness, and the kind of cleaning acid used. Groups consisting of the same material and thickness are normally processed together. If materials of various thickness are mixed, the material should be immersed sequentially from thick materials to thin materials. If a lot of millscale and rust must be removed, the surface should be roughly derusted by a disc sander or by an impact tool before pickling. The inside surface of steel pipes should be cleaned by blowing with compressed air prior to pickling. After acid cleaning, neutralization, water washing and drying are required.

The coating should be applied when the material surface is completely dried. Acid pickling is used as a primary surface preparation method.

4) Vacuum Blasting:

In vacuum blasting, the abrasive (emery) is propelled on to the steel surface by means of compressed air (about 5 kg/cm^2). The abrasive, rebounding off the steel surface, is retrieved by a vacuum pump through a vaduum cup. the abrasives then can be recycled by being fed back to a collecting tank.

As the operation pe-ed of this method is slower than regular sand blasting, it is not suitable for "processing large areas. Therefore, its use is normally limited to the repair of small areas. However, this method is desirable from a pollution control standpoint as the abrasives and dust are collected, thus preventing contamination of the surrounding area.

5) Mechanical Surface Preparation:

Mechanical surface preparation devices **powered by** compressed air are controlled by a single operator. These mechanical derusting tools are the most widely used in secondary surface preparation. The following shows the mechanical surface preparation methods and their various applications.

PREPARATION METHODS	MOTION	RUST REMOVE AL	MILL-SCALE REMOVE AL	SLAG & SPATTER REMOVE AL	REMARKS
POWER DISCSANDER	CIRCULAR	○	△		
POWER BRUSH	-	○			
JET CHISEL	TO-AND-FRO MOTION	○		△	
POWER SMALL WIRE BRUSH	CIRCULAR	○		△	FOR CLEANING DRAIN VALVES AND OTHER SMALL IN ACCESSIBLE PARTS
POWER SMALL GRINDER	-	○	△	△	
AUTO HAMMER DESCALER	-	○		△	

The following chart describes the type of primary surface treatment and the cleaning grade required for different ship areas.

TREATMENT AND GRADE	APPLICABLE AREA.
REATMENT: SHOT ABRASIVE BLASTING CORRESPONDING TO S1S BSa 2-1/2	APPLIED TO ALL AREA AND/OR MATERIALS, EXCEP FxT THE OLLOWING: STEEL MAST, POST AND BOOM, VENTIALTOR, VENT DUCT, DECK PIPING,. ENGINE ROOM, STEERING ROOM, PUMP ROOM PIPING, FLOOR PLATE IN ENGINE ROOM, STEERING ROOM, PUMP ROOM, ANCHOR, ANCHOR CABLE, MAIN ENGINE, BOILER, AUXILIARY MACHINERY, SURFACE OF DOUBLE BOTTOM IN CARGO HOLD

The following three charts describe, by applicable ship area, the method of secondary surface preparation to be used for rusted or damaged areas.

TREATMENT AND GRADE	APPLICABLE AREA
TREATMENT: DISC SAND AND/OR POWER BRUSH GRADE: CORRESPONDING TO S1S APPROXIMATELY ' Cst 3, BSt 3	EOTTOfd SHELL, OUTSIDE OF RUDDER, CEILING AND WALL OF BALLAST/CARG6 HOLD INTERIOR, LUBE OIL TANK IN DOUBLE BOTTOM, FRESH AND DRINKING WATER TANK DISTILLED WATER TANK, WATER BALLAST TANK, FORE PEA&AFT PEAK TANK, SLOP TANK

TREATMENT AND GRADE	APPLICABLE AREA
TREATMENT: DISC SAND AND/OR POWER BRUSH GRADE: CORRESPONDING TO SIS BETWEEN CSt 2 & CSt 3 BSt 2 & BSt 3	BOOT-TOP AND TOP SIDE SHELL, INSIDE OF RUDDER AND STERN FRAME, RUDDER TRUNK, DECK, UNDER DECK MACHINERY, DECK HOUSE, DECK STORE, OUTSIDE OF FUNNEL, MAST, POST AND BOOM, BOLLARD, BOAT DAVIT, VENTILATOR, DECK MACHINERY AND SEAT, CARGO HATCH COVER AND COAMING (OUTSIDE), CEILING AND WALL IN BATTERY ROOM, REF. PROVISION STORE, TOP OF DOUBLE BOTTOM IN BALLAST/CARGO HOLD (BULK CARRIER), CEILING AND WALL IN CARGO HOLD (B/C), BILGE WELL IN CARGO HOLD (B/C), TOP OF DOUBLE BOTTOM, ENGINE ROOM WALL FROM FLOOR LEVEL DOWN TO DOUBLE BOTTOM, UNDER MACHINERY SEAT, BILGE WELL IN ENGINE ROOM, STEERING GEAR ROOM AND PUMP ROOM, CHAIN LOCKER, COFFERDAM, VOID SPACE

TREATMENT AND GRADE	APPLICABLE AREA
TREATMENT: POWER BRUSH GRADE: CORRESPONDING TO SIS APPROXIMATELY CSt 2, BSt 2	INSIDE OF FUNNEL, INSIDE OF MAST, POST AND BOOM, CEILING, WALL AND FLOOR OF CABIN, PUBLIC ROOM, SANITARY SPACE, DUTY ROOM, AND PASSAGE OF ACCOMMODATION, CEILING, WALL AND FLOOR OF PROVISION STORE, AND STORES, CEILING, WALL FROM CEILING DOWN TO FLOOR LEVEL IN ENGIN ROOM, PUMP ROOM AND STEERING GEAR ROOM, ETC., ENGINE FLAT IN ENGINE ROOM, PUMP ROOM, AND STEERING GEAR ROOM, ETC., PIPES EXCEPT GALVANIZED, AND THOSE UNDER FLOOR PLATE OF ENGINE ROOM, PUMP ROOM, STEERING GEAR ROOM, ETC., MAIN ENGINE, BOILER

Just before applying shop primer, or overcoating, the surface should be clean. Figure 4-5 shows the approximate grade and the procedure of cleaning for the different types of dirt on the steel surface

A vital element to the zone oriented painting method is to automatically apply the shop primer utilizing automatic shot blasting as the primary surface preparation method "Section 5 discusses the process and benefits of applying shop primer.

ITEMS	GRADE-OF CLEANING	CLEANING PROCEDURE
SWEAT, SALT WATER	NOT DETECTABLE VISUALLY	SALT WATER SHOULD BE REMOVED WITH FRESH. WATER SWEAT SHOULD BE WIPED OFF OR BLOWN DRY
OIL AND GREASE	NOT DETECTABLE VISUALLY	JJIPE OFF WITH SOAP OR THINNEF!, MACHINERY FLUSHING, OIL TO BE EMULSIFIED AND THEN WASHED WITH WATER
SOAP FOR TANK TEST	NOT DETECTABLE VISUALLY	WASHED WITH WATER OR REMOVED BY POWER BRUSH
CHALKING	REMOVABLE BY FINGER TOUCH	TO BE REMOVED BY POWER BRUSH
SMOKE BY WELDING OR GAS CUTTING	SAME AS ABOVE	TO BE WIPED OFF BY DRY WASTE CLOTH
CHALK	TO BE WIPED OFF BY WET CLOTH	
‘AINT FOR !ARKING	DO NOT REMOVE	
SPLATTER PREVENTIVE MATERIALS	DO NOT REMOVE IF PAINT COMPATIBLE	
OTHER MISCELLANEOUS DIRT	WIPE OFF BY CLOTH	

Figure 4-5: Grade and Procedure of Surface Cleaning

5.0 SHOP PRIMER APPLICATION METHOD '"

The primary process of the shop primer application is automatically carried out on a 'conveyor line, as shown in Figure 5-1. The steel is automatically shot blasted to derust and remove millscale. The grit is propelled by high speed rotary impellers and is recycled. Steel plates and shapes are continuously coated with shop primer by automatic spray treatment. The steel is then transferred to the fabrication shop for" marking, cutting, bending and welding. This coating system is the prefabrication shop primer method (hereafter referred to as the "shop primer method").

If electro-photographical marking (E.P.M.) is used, the shop primers used must be compatible.

Most Japanese shipyards utilize the prefabrication shop primer method to enhance the service life of the more sophisticated coating systems being used. In adOpting this method, excellent surface treatment is essential to assure good paint performance.

The main function of shop primer coating in ZPTM is to temporarily prevent corrosion of the steel surface during the period from shot blasting to application of the specified coating. In addition, the shop primer material must provide good adhesion between itself and the subsequent coating to be applied. It must resist burning and damage from gas-cutting, bending and welding at the fabrication and assembly stages.

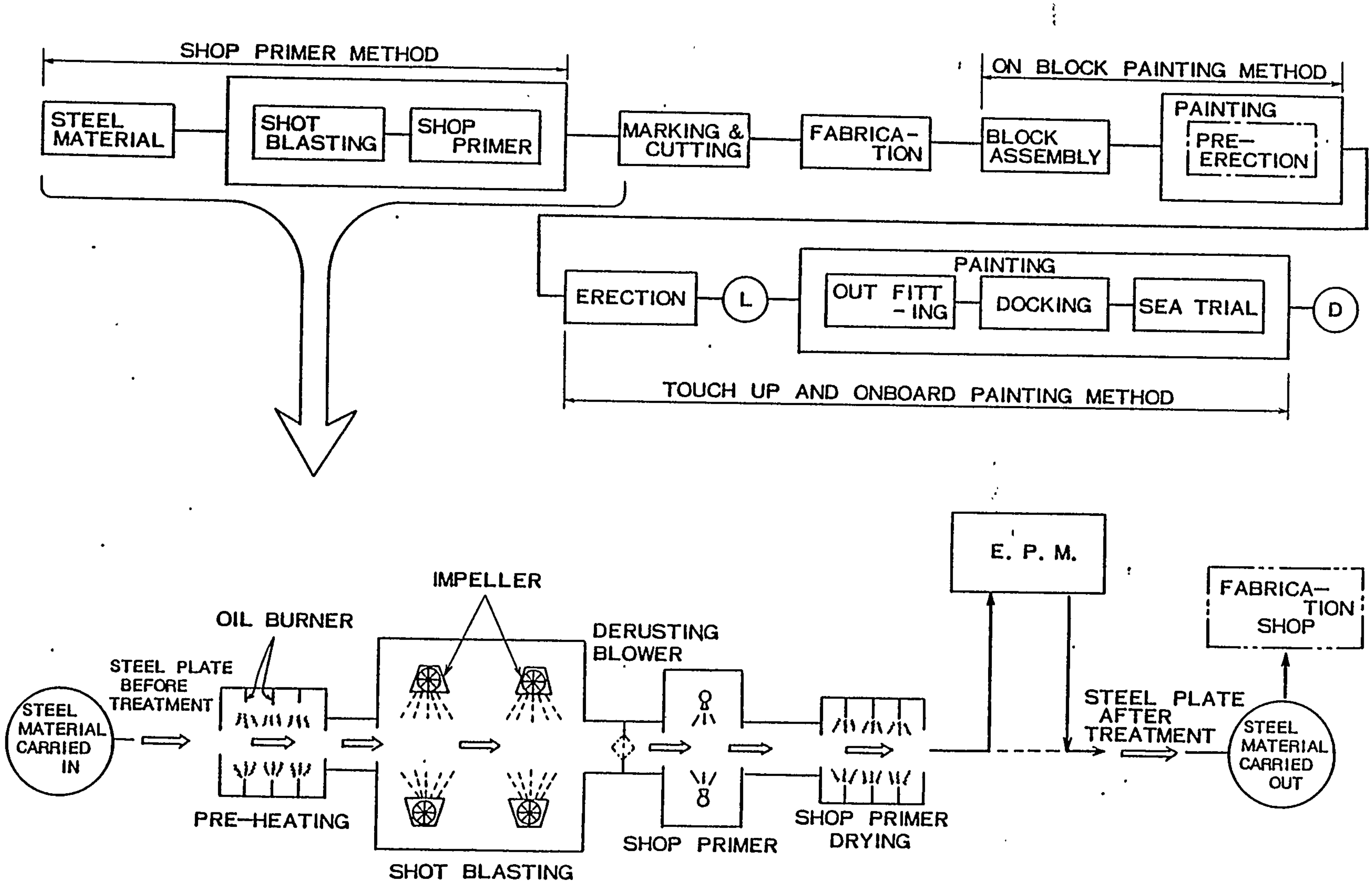


Figure 5-1: Shop Primer Method Flow Diagram

The adoption of the shop primer method in Japanese shipyards has contributed to improvements in safety, accuracy and productivity. Productivity has been remarkably improved due to the following factors:

- The process from shot blasting to application of shop primer can be carried’”out automatically in one stage. Thus , the productivity is very good; a coating rate of 1000 square meters/hour or better can be obtained.
- The removal of millscale at the on-block stage requires about three times the man-hours and about four times the quantity of grit compared to the prefabrication shop primer method using automatic shot blasting.
- Surface preparation by automatic shot blasting is used in the shop primer method while sand blasting or power tools were historically used at the bLock stage or after erection. The work efficiency of this method is approximately 15 times less efficient than with the automatic shot blasting method.
- Surface preparation productivity decreases during the latter stages of production. For example, the man-hours for surface preparation at the on-board stage will require about 2-5 times that of the man-hours required at the on-block stage. This is because scaffolding and ventilation are required as well as decreased work efficiency due to unsafe and unstable working conditions.

As shown in Figure 5-1, shop primer coating is usually carried out after primary surface preparation by automatic shot blasting. This coating process is the only process which can utilize automatic equipment throughout the whole painting process in the shipyard. Applying the primer by automatic spraying is four times more productive than applying it by airless spray at the on-block stage.

The automatic coating application is done by conventional air spraying. The coating thickness applied is determined by the speed of the conveyor line and the speed of the spray gin transversing the object. The relation between the speed of the conveyor line and the spray gun is given by the following formula:

$$\frac{L}{v} \quad \frac{P}{Te}$$

Where: L: Length of one stroke of spray gun (m)
v: Operating=speed of spray gun (m/min.)
P: Pattern breadth (m)
Ve: Moving speed of conveyor line (m/min.)

The tip size of the spray gun should be selected to suit the type of shop primer being sprayed. This information is available from the paint supplier.

In applying shop primer coating, ambient conditions SuCh as temperature and humidity should be monitored. Figure 5-2 depicts the required dry film thickness, temperature, humidity and pot life for the different type of primers.

For practical application, attention should be paid to these additional restrictions:

1) The working area for the application of shop primer coating should be adequately ventilated, particularly for alkalisilicate inorganic zinc primer, due to the high volatility of its solvents.

2) Automatic spraying equipment should be inspected and nozzle tips should be checked periodically for erosion. this ensures the proper atomization of the primer.

KIND OF PAINT	APPLICABLE SHOP PRIMER	DRY FILM THICK	WORKING METHOD	WORKING CONDITION		POT LIFE
				TEMP,	REL. HUMID.	
OIL BASE TYPE	WASH PRIMER	15 P 25; B	SHOP PRIMING METHOD	>573	<85 %	5°C/72H 10°C/60H 20°C/48H 30°C/24H
VINYL ESIN TYPE	ZINC EPOXY PRIMER	15 B 20!I p				
CHLORINATED RUBBER IYPE	NON- ZINC EPOXY PRIMER	-15 /u- 25: B				
ZPOXY RESIN TYPE PAINTS	WASH PRIMER	15 μ ∫ 25 μ	SHOP PRIMING METHOD	> 5 %	<85%	SAME AS 4BOVE
	ZINC EPOXY PRIMER	15 μ 20; p				
	NON-ZINC EPOXY PRIMER	15 ,ff 25: .u				
INORGANIC ZINC PAINT	SODIUM SILICATE TYPE	20 p	SHOP PRIMING OR A-S BLASTED	>5°C	>40% :85 %	20°C/24H
	ALKYL SILICATE TYPE					

Figure 5-2: Shop Primer Working Conditions

3) In order to minimize spray loss, limit switches should be checked frequently and adjusted to provide accurate on and off gun control.

4) If dust, oil or grease are found on the steel surface before shop priming”, it should be completely removed by solvent cleaning.

5) Marking paints shoulD be compatible with the specified overcoat paint.

6) Water condensing on the shop primer will result in the formation of white corrosion products which will reduce the efficiency of the E.P.M. by reducing the marking clarity. Therefore, the primed surfaces should be protected against moisture.

7) If a different type of shop primer is applied to the opposite side of the steel surface to which an inorganic zinc type shop primer is applied, care should be taken to avoid contamination of the inorganic zinc primer.

It is important to select a shop primer which is compatible both with the work process and with the subsequent applied coating. The characteristics required for shop primers are a follows:

- The life of the primer, against weather exposure, should be sufficient to maintain an anti-corrosive ability up to the on-block coating stage.
- The primer should have good adhesion with the overcoat paint.
- The primer should have sufficient heat resistance to withstand gas cutting and welding, and also have sufficient film strength to protect against abrasion and mechanical impact.

Figure 5-3 compares the features of four types of shop primers. The advantages and disadvantages of each material are indicated in terms of ease of painting, strength of paint film, durability, and other factors.

Priming the steel protects the steel from corrosion from the time the surface is blasted until the paint is applied. Under the zone oriented painting method, a major emphasis is placed on moving much of the painting from the on-board stage to the on-block stage. This shortens the time between applying the primer and applying the next paint coat, thus reducing corrosion and deterioration of the primer.

ITEMS		LONG TERM WASH PRIMER	ZINC EPOXY PRIMER	NON-ZINC PRIMER	INORGANIC ZINC PRIMER
EASE OF PAINTING	AIRLESS SPRAY	○	○	○	○ (△)
	AIR SPRAY	○	○	○	○
	BRUSH	○	△	○	△
STANDARD FILM THICKNESS (μ)		15 ~ 20	10 ~ 15	20 ~ 25	15 ~ 20
DRYNESS (20℃)	TREATMENT RANGE FOR COAT'G	MINUTES 3 ~ 5	2 ~ 3	2 ~ 3	1 ~ 2
	HARDENING TIME	HOURS 0.5	16	8	1
STRENGTH OF PAINT FILM	ANTI-ABRASION	△ ~ ×	○	○ ~ (△)	○
	ANTI-IMPACT	○	○	○	(△)
	ANTI-BENDING	○	○	○	(△)
TREAT-MENT	CUTTING	○ ~ (△)	(△)	○	○
	WELDING	○ ~ (△)	(△)	○	○
RESISTANCE FOR BURNING		△	○	(△)	○
DURA-BILITY	WATER/SALT WATER RESISTANCE	×	○	○	○
	EXPOSURE RESISTANCE	△	○	(△)	○
ADHESION TO UPPER COAT	CHLORINATED RUBBER PAINT	○	○	○	○ ~ (△)
	VINYL CHLORIDE PAINT	○	○	○	○
	EPOXY PAINT	○ ~ (△)	○	○	○
	TAR EPOXY PAINT	○ ~ (△)	○	○	○
	INORGANIC ZINC RICH PAINT	×	×	×	○
EFFICIENCY FOR SECONDARY SURF. PREP.		△	○	(△)	○
NOTES					ALKIL-CILICATE SHOP PRIMER
		GOOD/AVAILABLE ← ○ (△) △ × → BAD/NOT AVAILABLE			

Figure 5-3: Comparison of Shop Primer Characteristics

(Taken from "Kogyo Toso No. 5")

6.0 ON-BLOCK PAINTING

The on-block painting method is the most popular method applied in Japanese shipyards under the zone oriented painting method. A detailed work procedure is illustrated in Figure 6-1. This iS divided into process steps: preparing for painting, painting, and the inspection and repair after painting. Stripe coating (normally called “touch up”) is carried out on selected areas before applying the overcoat. Details of touch up coating are described in Section 6.3. The process of on-block painting is as follows:

- Checking the quality of paint material and selecting the appropriate paint equipment and tools.
- Sweep clean and/or degrease before painting.
- Stripe coating (touch up) on unfinished-or damaged areas (on-block).
- Overcoating by spraying.
- Inspecting after painting.
- Applying additional coating to repaired areas as required.

Figure 6-2 shows an example of painting work stages based upon the assembly schedule. Each painting work stage is scheduled with the following considerations:

- Minimize scaffolding.
- Selection of the safest working position.
- Maximization of coating quality.

In order to fulfill the above requirements, the planning of the hull block arrangement and assembly “schedules are very

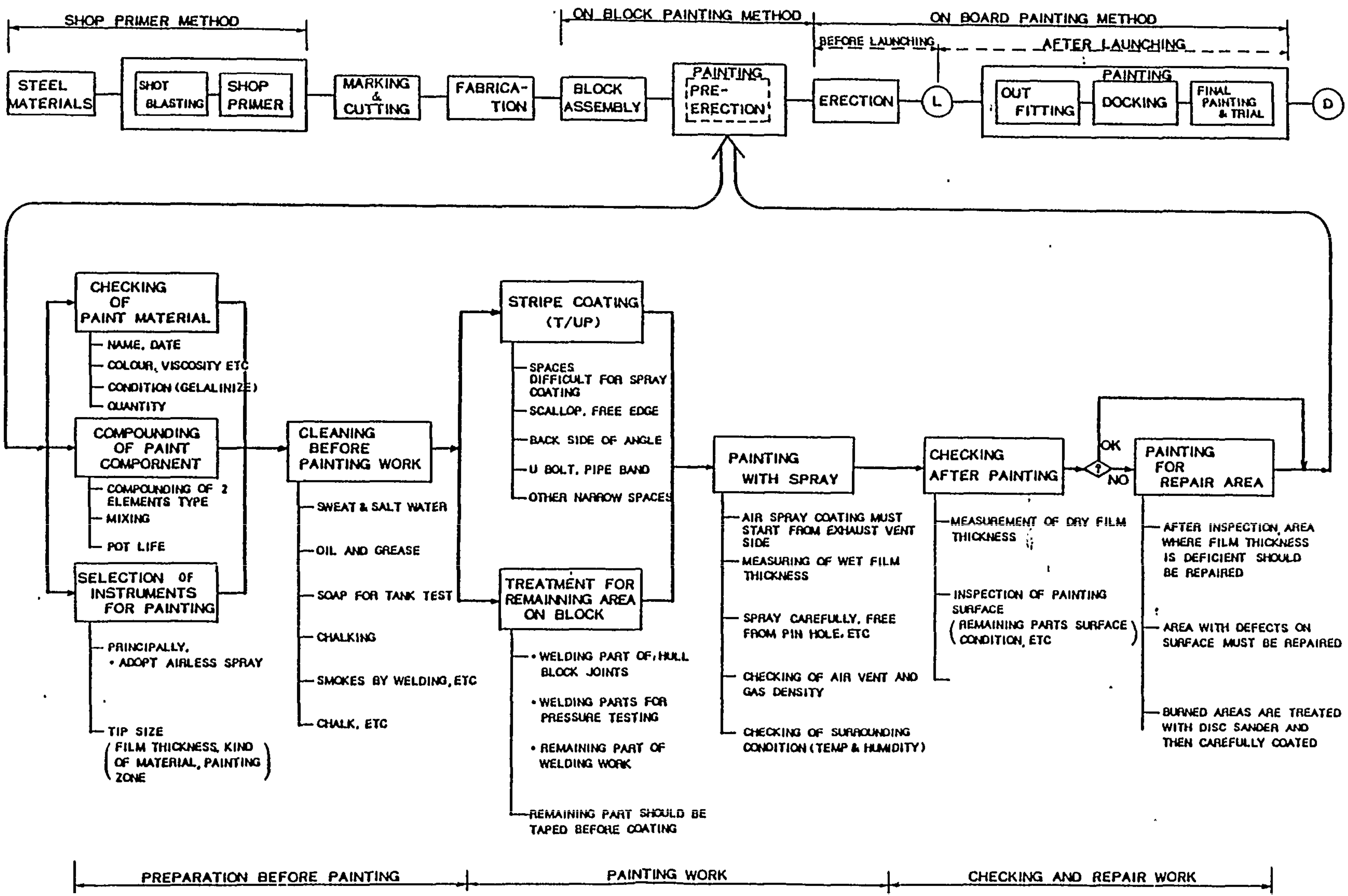
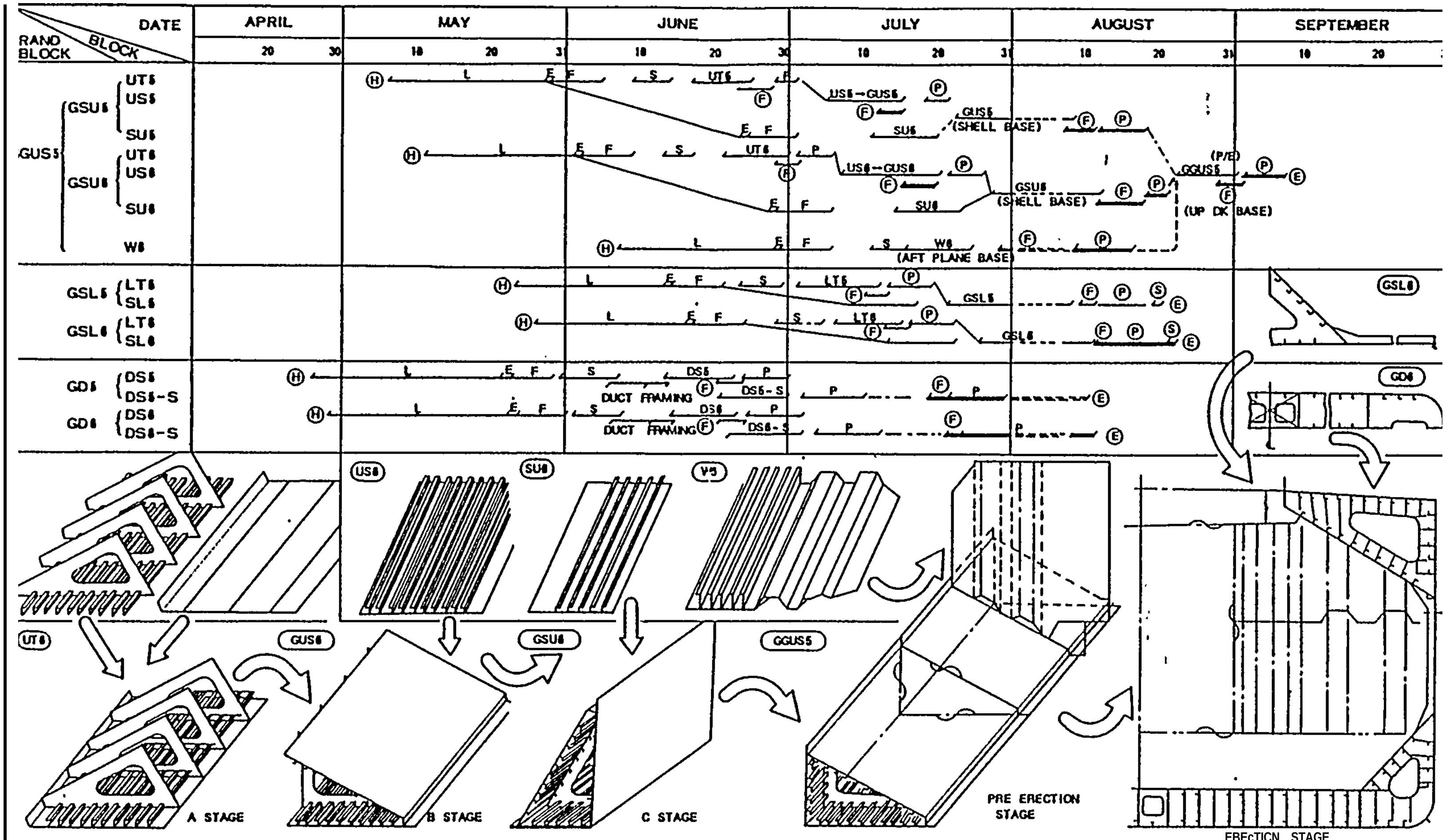


Figure 6-1: Functions at the On-Block Painting Stage



NOTES; @ ISSUING DATE OF HULL PART DRAWING
L : hUJLD LOFT WORK
E: E.P.M.
F : FABRICAT0ION
S : SUB-ASSEMBLY
P , @ PAINTING WORK
@: OUTFITTING WORK
@: ERECTION

Figure 6-2: Painting Stages in a-Block Assembly Schedule

important. Therefore, assembly planning of hull blocks should be carried out simultaneously with paint planning.

Figure 6-3 shows an example of the Hull Block Arrangement Plan. It is desirable to plan painting using the same block division as the hull blocks.

The areas to be painted during the on-block stage should be selected to improve work efficiency, as well as safety and quality control. Generally, it is desirable to plan to do as much painting as possible at the on-block stage. However, in considering available man-power, some of the painting may have to be shifted to the on-board stage. The priority order of paint work should be determined based upon the danger level of the painting zone and/or area, the characteristics of the paint material and productivity. The levels of danger vis-à-vis the painting zone, and by the type of paint, are shown in Figures 6-4 and 6-5, respectively. Compartments, which are graded as a No. 2 or No. 3 level of danger, may be shifted from the on-block stage to the on-board stage. Derrick posts, booms, stacks, etc., should be painted at the on-block stage for safety reasons.

6.1 Temperature and Humidity

Paint must be applied within the limitations of the ambient temperature and humidity conditions. If the temperature and/or humidity can be adjusted to meet application requirements by means of heating and/or dehumidification equipment, the paint can be applied irrespective of ambient conditions. Prior to coating application, the surface should be checked for condensation. Coating intervals depend on the humidity and temperature. Minimum and maximum coating intervals for each type of coating is given in the following table, according to the ambient temperature and humidity conditions.

KIND OF PAINT	FILM THICK (μ) (MICRON)	COATING INTERVAL (MINIMUM / MAXIMUM)				
		5℃	10℃	20℃	30℃	TOUCH UP
OIL BASE PAINT	30	30H	20H	16H	10H	5H
		—	—	—	—	—
CHLORINATED RUBBER PAINT	35	5H	4H	3H	2H	2H
		—	—	—	—	—
VINYL RESIN PAINT	25	5H	4H	3H	2H	1H
		—	—	—	—	—
EPOXY RESIN PAINT	70	44H	24H	16H	12H	8H
		90 DAYS	90 DAYS	90 DAYS	90 DAYS	—
TAR EPOXY RESIN PAINT	125	44H	24H	16H	12H	8H
		7 DAYS	5 DAYS	5 DAYS	2 DAYS	—
	180	44H	30H	16H	12H	8H
		7 DAYS	5 DAYS	5 DAYS	2 DAYS	—
URETHANE RESIN PAINT	180	13H	8H	5H	—	—
		30 DAYS	30 DAYS	30 DAYS	—	—

The minimum time interval between final coating and water immersion for the different type of paints is:

- Oil Paint - 10 hours
- Chlorinated rubber paint 5 hours
- Vinyl resin paint 5 hours

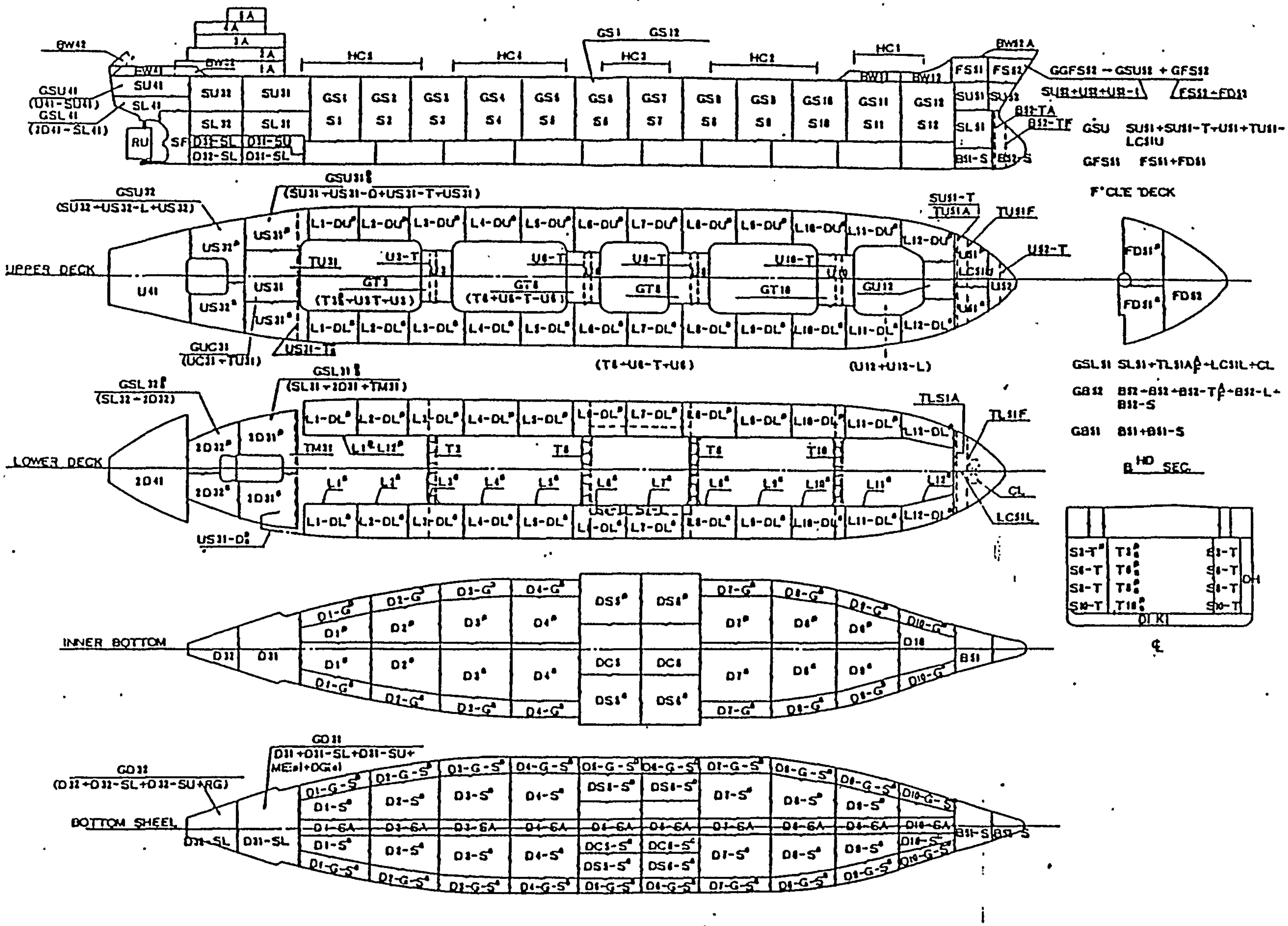


Figure 6-3: A Hull Block Arrangement Plan

LEVEL OF DANGER	ZONE, AREA/COMPARTMENTS
NO. 1 8Y GRADE OF ZONE, AREA (HIGHEST)	TANKS; FORE PEAK TANK, AFTER. -PEAK TANK FRESH WATER TANK, FUEL OIL TANK, CARGO OIL TANK, BALLAST WATER TANK, VOID SPACE, COFFERDAM ENCLOSED SPACES; CHAIN LOCKER, RUDDER TRUN STORE AND SIMILAR SPACES =
NO. 2 8Y GRADE OF ZONE, AREA	ENGINE OOM, BOILER PUMP ROOM CARGO HOLD, CABINS AND PASSAGES IN LIVING QUARTERS DECK STORE, AND SIMILAR SPACES
No. 3 BY GRADE OF ZONE, AREA	WEATHER EXPOSED AREAS; UPPER DECK, SHELL, SUPERSTRUCTURES. (EXTERNAL), PANEL 13LCCKS, (EFFECTIVE BY NATURAL VENT)

Figure 6-4: Level of Danger by Zone/Area

LEVEL OF DANGER	KIND OF PAINT MATERIAL
NO. 1 DANGER GRADE OF PAINT WIGliESTI	WASH PRIMER, EPOXY RESIN PAINT, TAR EPOXY PAINT, CHLORINATED RUBBER PAINT,LACQUER, ETC., AND THINNERS FOR THE ABOVE
No. 2 DANGEl? GRADE OF PAINT	ZINC CHROMATE PRIMER, WHITE RUST RESIST-PREVENTIVE! PAINT, PHTHALIC RESIN PAINT, PHENOL RESIN PAINT. OTHER SYNTHETIC RESIN PAINTS AND PAINT THINNER, ENAMEL THINNER, HEAvy FUEL OIL.

Figure 6-5: Level of Danger by Type of Paint

The minimum time interval between final coating and immersion for epoxy resin paint depends on the ambient temperature as ollows:

Temperature	5°c	10”C	2o”c	3o”c
Period	14 days	12 days	7 days	. 7 days

6.2 Equipment

Adequate tools and equipment must be provided to assure safe, efficient and quality coating work. The following painting equipment and tools are used.

1) Brush:
The Brush- is the most primitive tool for painting, and the paint is applied by lengthwise and crosswise movements of the brush. Brush painting on rough surfaces , rivet heads, edges and angles , require careful operation.

2) Roller Brush:
Painting by roller brush is mainly applied on even surfaces. The paint should not be spread excessively, and special care must be paid to painting welding beads and rivet heads.

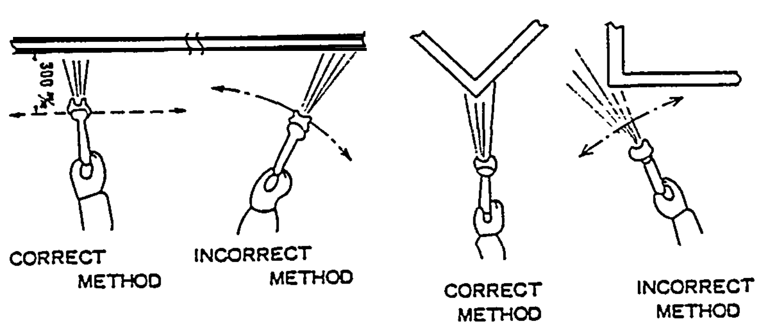
3) Air Spray Gun:
This device atomizes the paint by compressed air, and sprays the paint on the surface. There are two types of guns: the cup type and the pressure pot type . In shipyards, the cup type spray guns are

used only for special coatings, small areas, or when many changes of paint colors are required.

4) Airless Spray Machine:
This type is the most widely used tool in marine painting. The spray guns are classified by pressure ratios. The amount of pressure is selected depending upon the type of paint and its viscosity. By this device, the paint is sprayed at a high pressure by means of a plunger pump, operated by compressed air. The paint becomes atomized when forced through the nozzle tip.

Spray coating is applied, under the following conditions :

- Selection of a tip size to suit the type of paint.
- The distance between the coating surface and the tip of the spray nozzle should be kept at above 300 m/m. However, under certain work conditions, the distance of up to 400 m/m may be acceptable.
- The spray gun should always move parallel to the coating surface, as shown below, and the spray. gun moving speed should be kept at about 1 m/see.



* MOPVvO/E THE SPRAY IN A STRAIGHT LINE

- In order to keep the specified film thickness, and to prevent the paint film from sagging and running, spray coating should be carried out by overlap coating and/or cross coating.

Airless spray has the following advantages:

- Thicker film thickness, from 200 microns to 500 micron"s, can be obtained per coat.
- High viscosity paints may be sprayed without thinning.
- High work efficiency.

  Paint quality is improved due to less overspray and the elimination of possible contamination with water or oil.

The chart below compares the coating efficiency by method of application - brush, roller brush and airless spray.

Coating method	Coating efficiency	Loss of paint	Cost of device	Total cost
Brush	1	3%	Low	High
Roller brush	3	10%	Low	High
Airless spray	10	20%	High	Low

6.3 Touch Up Method

Most of Japan's shipyards utilize steel plates and shapes which have been shot blasted and shop primed at the steel mill or the shipyard. They then apply the specified coating over the shop primer after assembling the hull block.

During this process, on-block outfitting is carried out as shown in Figure 6-1. During block assembly and on-block outfitting, the coated surfaces that are damaged by burning or other-reasons are cleaned by power tools and coated with shop primer or the specified coating to maintain paint performance.

This procedure is called the “TOUCH UP METHOD”. Surface preparation for the touch up method is usually carried out with a disc sander, and the coating by paint brushes.

The touch up method is becoming more popular in shipbuilding as it enhances productivity, while maintaining surface protection during the production period, giving good adhesion to the overcoat.

All hull construction, outfitting and painting processes, schedules and work are integrated and controlled throughout the ship’s construction period in accordance with the IHOP Schedule. During IHOP planning, production engineering should be carried out to minimize damage to the shop primer and paint. These considerations are very important, because minor time delays caused by repair of damaged paint at the early stage will greatly affect the painting at the final stage.

In addition to the above repair coating, painting of the hull block erection butt, seam joints and edges are also defined as a “touch up method”. The term “striping” is most often used in the U.S. to describe this process.

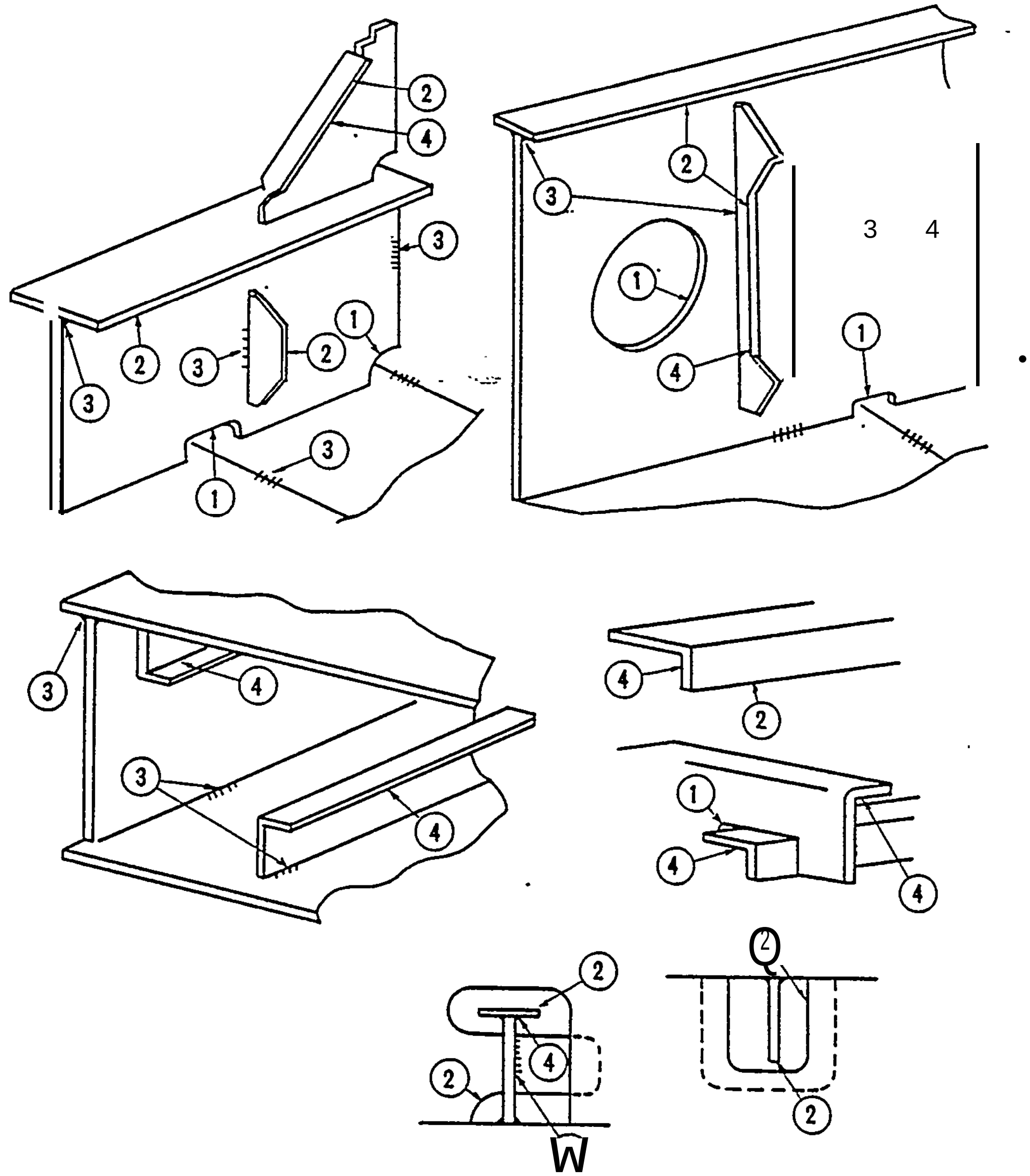
Touch up is a necessary process to enhance the block construction method. However, it is still desirable 'to minimize touch up work and, accordingly, studies are done during production planning to reduce areas of touch up work. The touch up method is normally applied in the following areas:

- Stripe coating on free edges and in narrow spaces where spray coating is difficult to apply. Where airless spray is difficult to apply, or when the required film thickness is difficult to maintain, stripe coating should be applied by brush, before or after spray coating. Some examples of stripe coating applications are illustrated in Figure 6-6 for holes, free edges, manual welding beads, and other difficult areas.
- Touch up of damaged areas caused by installing or removing paint scaffoldings.
- Touch up to burnt surfaces caused by welding in outfitting work.
- Painting welding seams and butt lines for hull block erection.
- Touch up to compensate deficient film thickness after inspection.
- Touch up of areas of defective paint material or poor workmanship.

The volume of touch up work will vary depending upon planning, scheduling and the total workmanship . The timing of outfitting work is especially important.

6.3.1 Film Thickness

For a plate area of 30 to 40 square meters of outer shell or deck, two points should be measured for film thickness and determination of the touch up area for the outer shell, as illustrated in Figure 6-7. Measuring points are selected at



NOTES; @ INSIDE AND EDGE OF HOLES

@: FREE EDGE

@: MANUAL WELDING BEADS

@; WHERE PAINTING IS DIFFICULT FOR SPRAY

Figure 6-6: Examples of Stripe Coating

This figure is taken,from “The Shipbuilders Association of Japan, Tank Coating Specifications for Product Carriers”

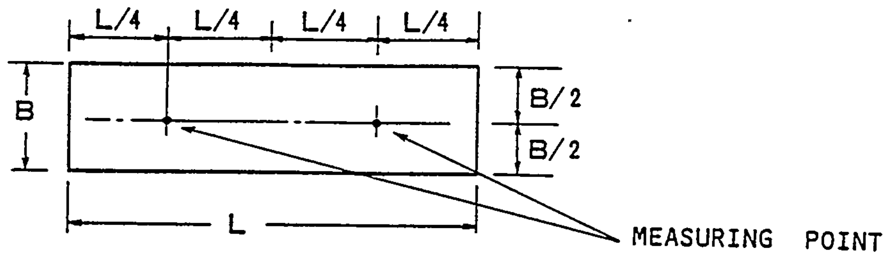


Figure 6-7: Measuring Points for Film Thickness (Outside Shell)

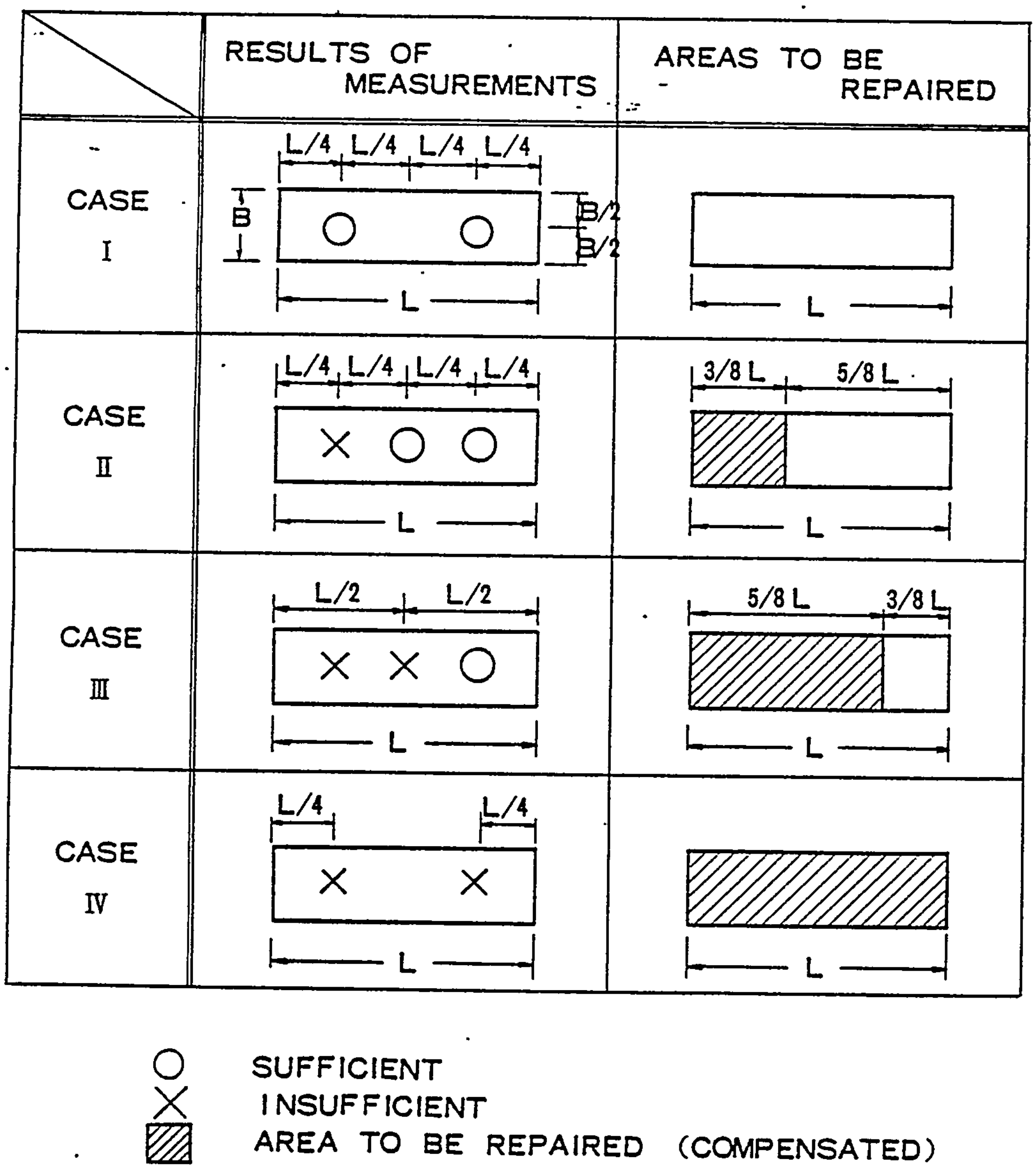


Figure 6-8: Repair Coating Area (Outside Shell)

the intersection of B/2 and L/4. Based on the results of the film thickness measurement, deficient coated areas should be compensated for by touch up painting, as illustrated in Figure 6-8.

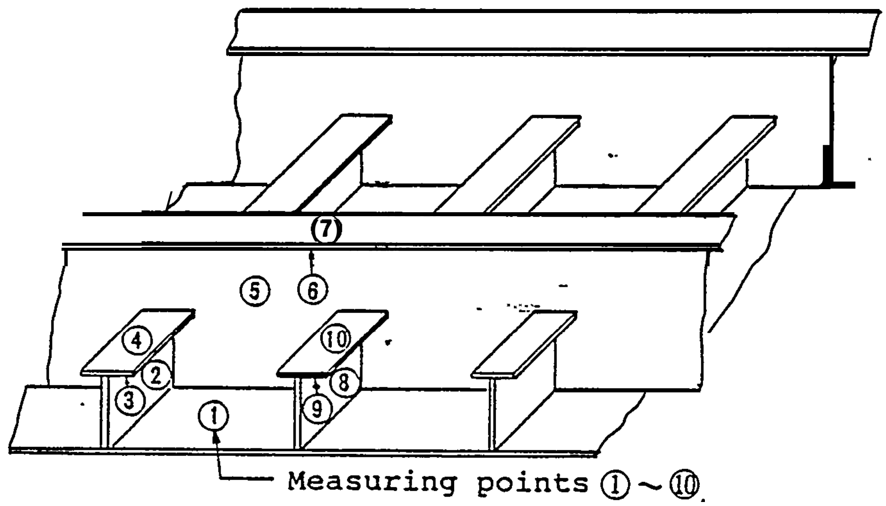
When epoxy resin paint or inorganic-zinc-rich paint are used for coating tanks, the following methods are used to measure film thickness and/or to touch up deficient paint film.

- If the tank coating surface is not fitted with stiffeners or longitudinal , etc., the measuring point is selected at a rate of one point per area of about 10 square meters and, if touch up is required to compensate for a deficiency in the film thickness, additional coating should be applied using the same means applied to the outer shell.

- If the tank surface is fitted with stiffeners or longitudinal, etc., one measuring point should be selected at each plane area (bay), which is bound by longitudinal and transverse webs (or stiffeners and girders) as shown in Figure 6-9. The interval of measuring points may be selected at a rate of one point per every 5 bays. If the film thickness is found deficient at the measuring point, additional measuring points should be taken at every alternate bay, i.e., spaced 2 bays apart, and then, the additional coating area to compensate for deficient film thickness should be determined as shown in Figure 6-10.

6.3.2 Repair Coating

Prior to touch up coating, surface preparation should be carried out on damaged areas. A disc sander is generally utilized in surface preparation for conventional paint

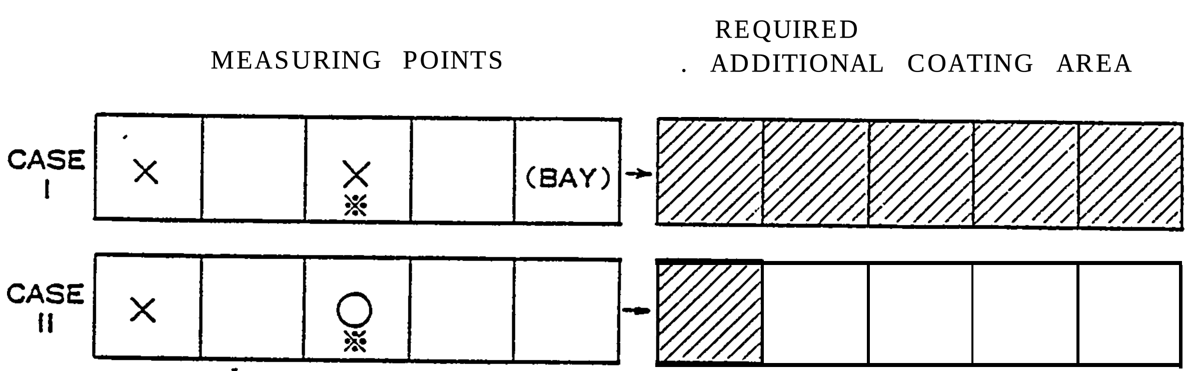


NOTES: 1) APPLICABLE AREA

- INSIDE OF BOTTOM SHELL
- INSIDE OF SIDE SHELL
- STIFFENER SIDE OF LONGITUDINAL BULKHEAD

2) MEASURING POINTS ARE SELECTED AT EVERY 5 BAYS

Figure 6-9: Measuring Points for Film Thickness (Tanks)



NOTES; 1)%MARK POINT IS AN ADDITIONAL MEASURING POINT

2)xMARK SHOWS FILM THICKNESS IS INSUFFICIENT

Figure 6-10: Repair Coating Areas (Tanks)

materials. For special ints, other surface preparation tools should be selected depending upon the kind of paint and the ship compartment. Figure 6-11 indicates applicable tools for use with ordinary paints, epoxy resin paints and inorganic zinc paints, according to the type of defect and ship area. Figure 6-12 diagrams surface preparation and touch up on damaged areas, and Figure 6-13 indicates the same in more detail for welded parts.

Figure 6-14 lists appropriate methods to repair defects on paint film and paint itself. The proper repair method is determined by the type of defect.

This section has dealt with the methods of on-block painting and the related issues (to both on-block and or-board painting) of temperature, equipment and touch-up painting. Although painting on-block has many advantages, there are ship areas which can not or should not be painted until the on-board stage. Section 7 discusses methods and issues of on-board painting, including final inspection criteria.

KIND OF DEFECT	ZONE/AREA	KIND OF PAINT MATERIAL		
		ORDINARY PAINTS	EPOXY RESIN PAINT	INORGANIC ZINC PAINT
DAMAGE BY BURNING	EXTERNAL AREA OR IMMERSED PARTS	DISC SANDER AND/OR POWER BRUSH	DISC SANDER AND/OR POWER BRUSH	TOTAL AREA: HEAVY BLAST PARTIAL AREA: VACCUM BLAST JET TAGANE
	INTERNAL AREA	POWER BRUSH		
DAMAGE BY RUSTING	EXTERNAL AREA OR IMMERSED PARTS	DISC SANDER AND/OR POWER BRUSH	DISC SANDER AND/OR POWER BRUSH	TOTAL AREA HEAVY BRAST PARTIAL AREA: VACCUM BLAST JET TAGANE
	INTERNAL AREA	POWER BRUSH		
DAMAGE. BY WELDING AND ITS VICINITY	EXTERNAL AREA OR IMMERSED PARTS	DISC SANDER AND/OR POWER BRUSH	DISC SANDER AND/OR POWER BRUSH	SAME AS ABOVE
	INTERNAL AREA	POWER BRUSH		
DE-RUSTING OF AREAS OF COATING ERRORS, OR AREAS NOT TREATED	EXTERNAL AREA OR IMMERSED PARTS	DISC SANDER AND/OR POWER BRUSH	DISC SANDER AND/OR POWER BRUSH	SAME AS ABOVE
	INTERNAL AREA	POWER BRUSH		
00M/M BELT AREA, ALONG WELDING BEADS OF BLOCK BUTTS OF BOTTOM SHELL	—	BLAST DISC SANDER AND/OR POWER BRUSH	BLAST	

Figure 6-11: Surface Preparation Tools By Type of Defect/Area

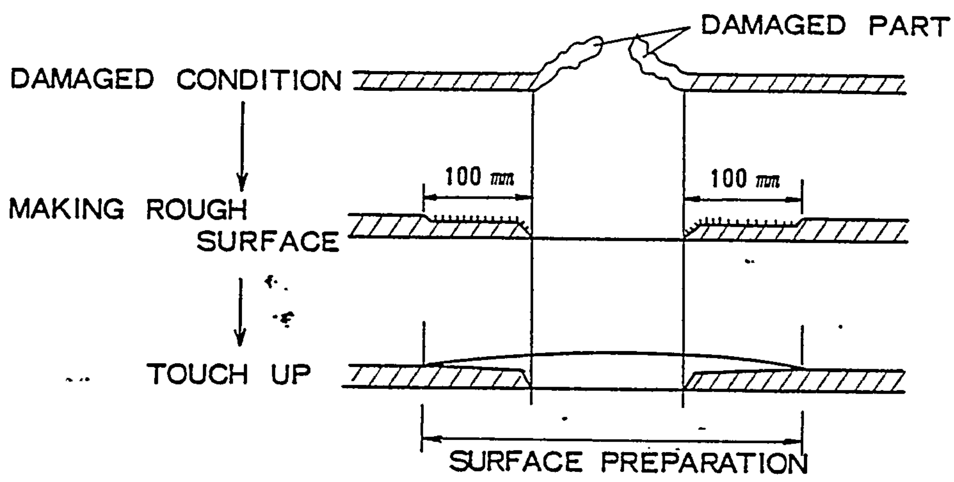


Figure 6-12: Surface Preparation/Touch-Up of Damaged Parts

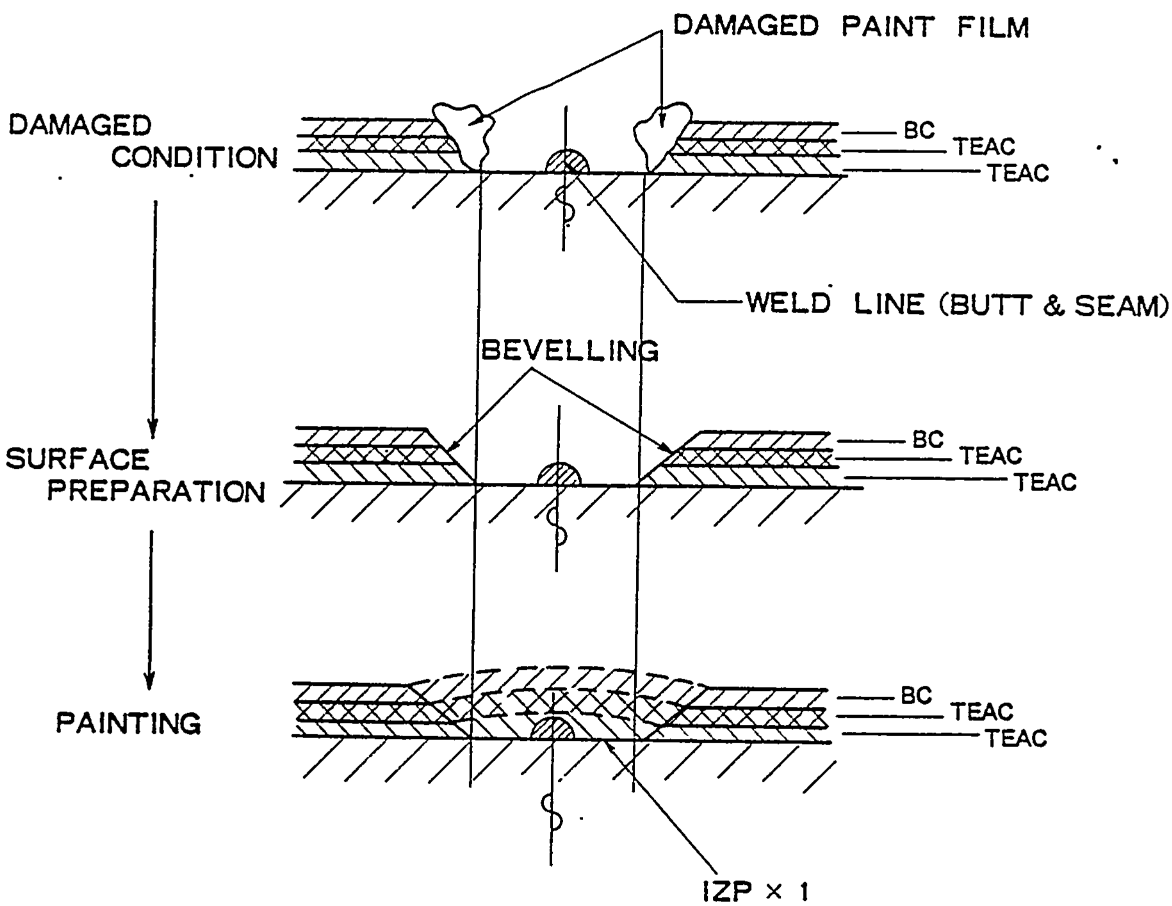


Figure 6-13: Surface Preparation/Touch-Up on Welded Parts

KIND OF DEFECT		REPAIRING METHODS
STORAGE	GELATION	DO NOT USE
	SETTLING	TO BE MIXED THOROUGHLY. USE IF DISPERSABLE
	SKINNING	REMOVE SKIN FILM AND MIX THOROUGHLY. FILTER WITH SMALL MESH NET
PAINTING AND DRYING	RUNS	IF SERIOUS, SCRAPE OFF THE FILM AND RECOAT
	ORANGE PEELING	TREAT WITH SAND PAPER, AND THEN SPRAY
	SAGS	SCRAPE OFF THE FILM AND RECOAT
	BUBBLING	SCRAPE OFF THE FILM AND RECOAT
	COBWEBBING	IF EXCESSIVE, REMOVE BY SCRAPING FILM AND RECOAT
	POOR ATOMIZATION	SAME AS ABOVE
	SAGGING & RUNNING	REMOVE BY SCRAPING AND RECOAT
	BRUSH MARKS, BAD LEVELING	SAND AND RECOAT
	PIN HOLES, PITTING, CRATERS	SAND AND RECOAT
	BLUSHING	IF EXCESSIVE, RECOAT
	BLEEDING	REMOVE PAINT FROM AREA AND RECOAT
	LIFTING	REMOVE PAINT AND RECOAT
	FLOCCULATION	REMOVE WITH SAND PAPER AND RECOAT
	KIND OF DEFECT	REPAIRING METHODS

PAINTING & DRYING	SLOW DRYING TIME	IF THE PAINT DOES NOT DRY, REMOVE AND RECOAT
	AFTER-TACK	SAME AS ABOVE
FILM CONDITION AFTER PAINTING	YELLOWING	RECOAT WITH ANOTHER COAT OF SAME PAINT
	DISCOLORING, FADING	SAME AS ABOVE
	CRACKING	REMOVE AND RECOAT
	BLOOMING	RECOAT WITH ANOTHER COAT OF SAME PAINT
	CHALKING	SAND AND RECOAT
	WRINKLING, SHRIVELLING	REMOVE AND RECOAT
	NON-UNIFORM GLOSS	OVERCOAT TO EVEN GLOSS
	DISCONTINUOUS FILM	RECOAT
	BLISTERING	REMOVE AND RECOAT
	RUSTING	REMOVE, REAPPLY SYSTEM
	CHIPPING AND SCALING	REMOVE, RECOAT
	BLACKENING	REMOVE BY DISC SANDER OR THINNER
	FOULING	REMOVE FOULING AND RECOAT

Figure 6-14: Repair Method by Type of Defect

7.0 ON-BOARD PAINTING

On-board painting is defined as that which is carried out at the hull block erection stage, launching, on-board outfitting, final docking and at ship’s delivery.

Generally; on-board painting is done from about a month before launching until after launch, when some repair of coating and final coating is carried out sequentially by zones and completed before the builder’s trial. The final coating of the outer shell is usually carried out at the final docking stage. After the official sea trial, the remaining repait, and coating work is completed.

The coating schedule after the official sea trial should be determined in detail and well coordinated to prevent interference of paint repair work with other crafts.

At the on-board painting stage, a lot of the work is confined in narrow spaces, or done on scaffoldings. Accordingly, the working conditions are not only unstable, but also less efficient. The painting man hours per area painted at this stage are about 20 to 50 percent more than the man hours required at the on-block stage, even though the paint area is smaller. The surface preparation and coating methods are almost the same as during on-block painting, but the equipment must be moved frequently which reduces the coating rate.

Figure 7-1 shows the major paint requirements at the on-board stage, corresponding with the major milestones of ship construction, from the hull block erection stage up to final

MAIN EVENTS	CONSTRUCTION PROCESS	PAINTING WORK
○ HULL BLOCK (ERECTION) ↓ (OUTFITTING)	○ BUTT WELDING OF HULL BLOCK JOINTS ● SURFACE PREPARA-TION OF WELDING BEADS OF HULL BLOCK JOINTS	● COATING OF HULL BLOCK JOINTS (UNDER COAT) ● OVER COATING OF OUTER SHELL (TOP SIDE, BOOT TOP, BOTTOM)
○ LAUNCHING ↓ (PIER SIDE)	OUTFITTING ON BOARD ● SURFACE PREPARA-TION OF DAMAGED AREAS	● PAINTING OF UNCOATED AREAS. ● REPAIR COATI DAMAGED AREAS
○ DOCKING ↓ (FINAL DOCK)	● SURFACE PREPARA-TION OF DAMAGED AREA OF BOTTOM SHELL	● COAT DAMAGED AREAS OF BOTTOM SHELL ● FINAL COAT (ANTI-FOULING) BOTTOM SHELL
○ UNDOCKING ↓ (PIER SIDE) ○ DELIVERY	○ SEA TRIAL	● FINAL COAT INTERIOR OF ACCOMODATION SPACE ● FINAL COAT DECKS AND EXTERIOR OF SUPERSTRUCTURE AND HOUSE ● FINAL COAT OF TOP SIDE AND BOOT TOP SHELL, ETC.

Figure 7-1: Major Paint Work at the On-Board Stage

delivery. Figure 7-2 is a much more detailed diagram of the painting procedure in coordination with other trades during the on-board stage.

Much of the painting is carried out at the on-block stage but, except for the cargo compartment, final coating is performed at the on-board stage in conjunction with outfitting. Thus, additional preparations from planning and engineering are required for the following:

- Plans for air ventilation.
- Plans for lighting.
- Plans for scaffolding.

1) Planning for Air Ventilation:

a) Manholes

The location and quantity of manholes should be determined based upon the shape and volume of the compartment to be painted, and the required air volume to, be changed. In planning the manholes for ventilation, the ship's existing structures, such as access hatches and manholes, are fully utilized. However, if the existing structures are not enough, additional openings must be arranged.

The following factors should be considered in planning the ventilation access openings.

- One manhole should be used exclusively as access for workers.
- To ventilate all areas and corners of the compartment, feed and exhaust holes should be arranged diagonally and/or symmetrically.
- In the case of small size tanks, air pipes may be utilized if manholes cannot be arranged.

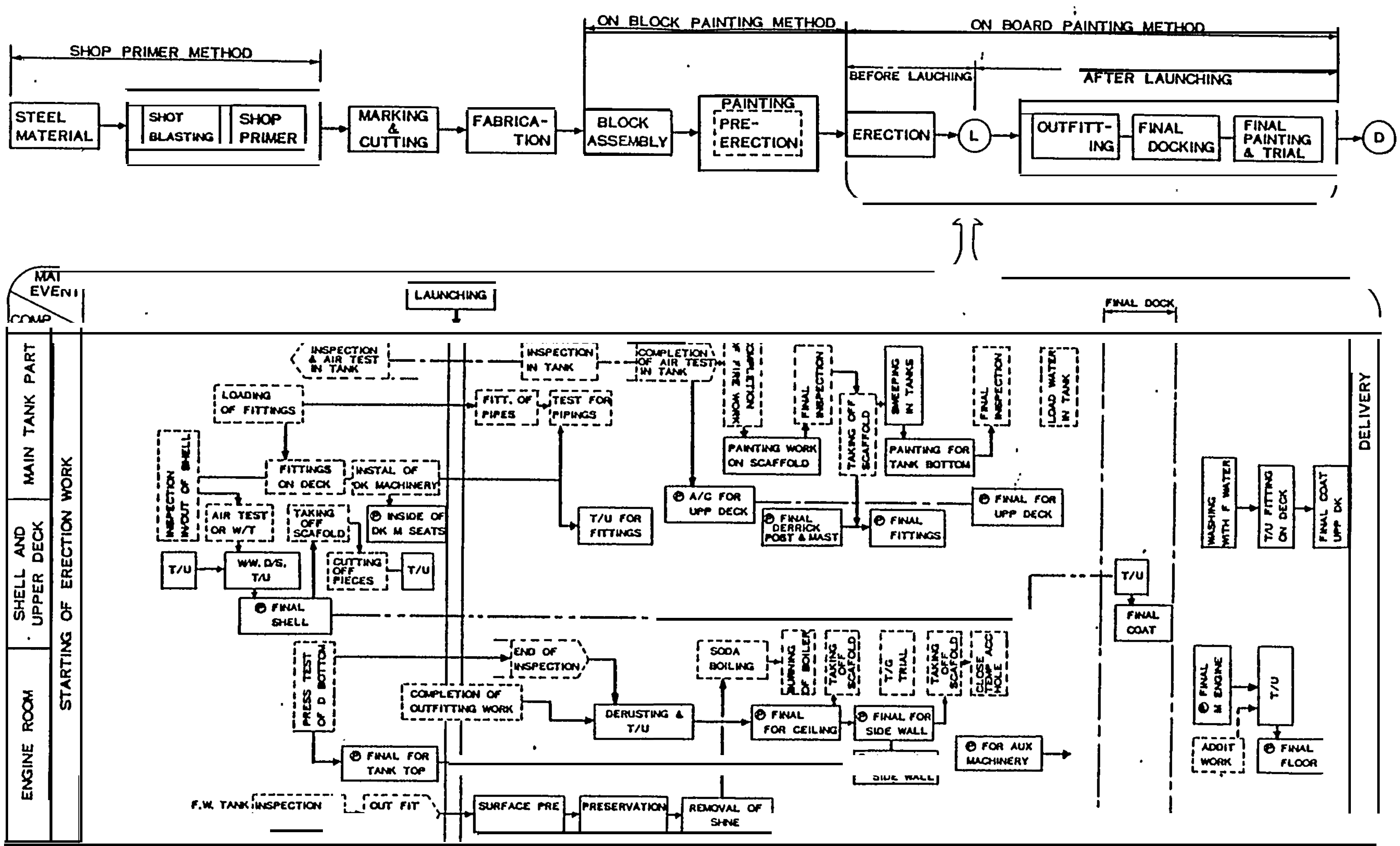


Figure 7-2: Sample On-Board Painting Procedure

b) Determination of the Air Volume.

The required air volume to ventilate a compartment of a No. 1 danger grade (as described in Figure 6-3) is given by the following equation:

$$Q = p \times \left(\frac{s + t}{100}\right) \times 0.03$$

where; Q: Required air quantity per minute, in cubic meters (m^3)

p: Quantity of .paint material consumed pe: hour, in gratis (g)

s: Pigment ratio included in the above paint material, in percent (%)

t: Volume ratio of thinner added, in percent (%) .

c) Determination of the Required Number of Ventilation Fans . The number of fans is determined by",the following formula:

$$F = \frac{Q}{A}$$

where; F: Number of ventilation fans

Q: Required air quantity, in m^3/min.

A: Capacity of the adopted ventilation fan, in m^3/min.

Figure 7-3 depicts two possible ventilation arrangements , for compartments fitted with two manholes and with one manhole. In planning the ventilation arrangement, the following should be taken into consideration:

- Bottom and corners of the tank compartment, where vapors are apt to remain, should be well ventilated by placing the air supply ducts exits in these areas to dissipate the vapors by forced air.
- Metal fittings and/or tips of the air hoses and ducts should be covered with tape to prevent electrostatic sparks.

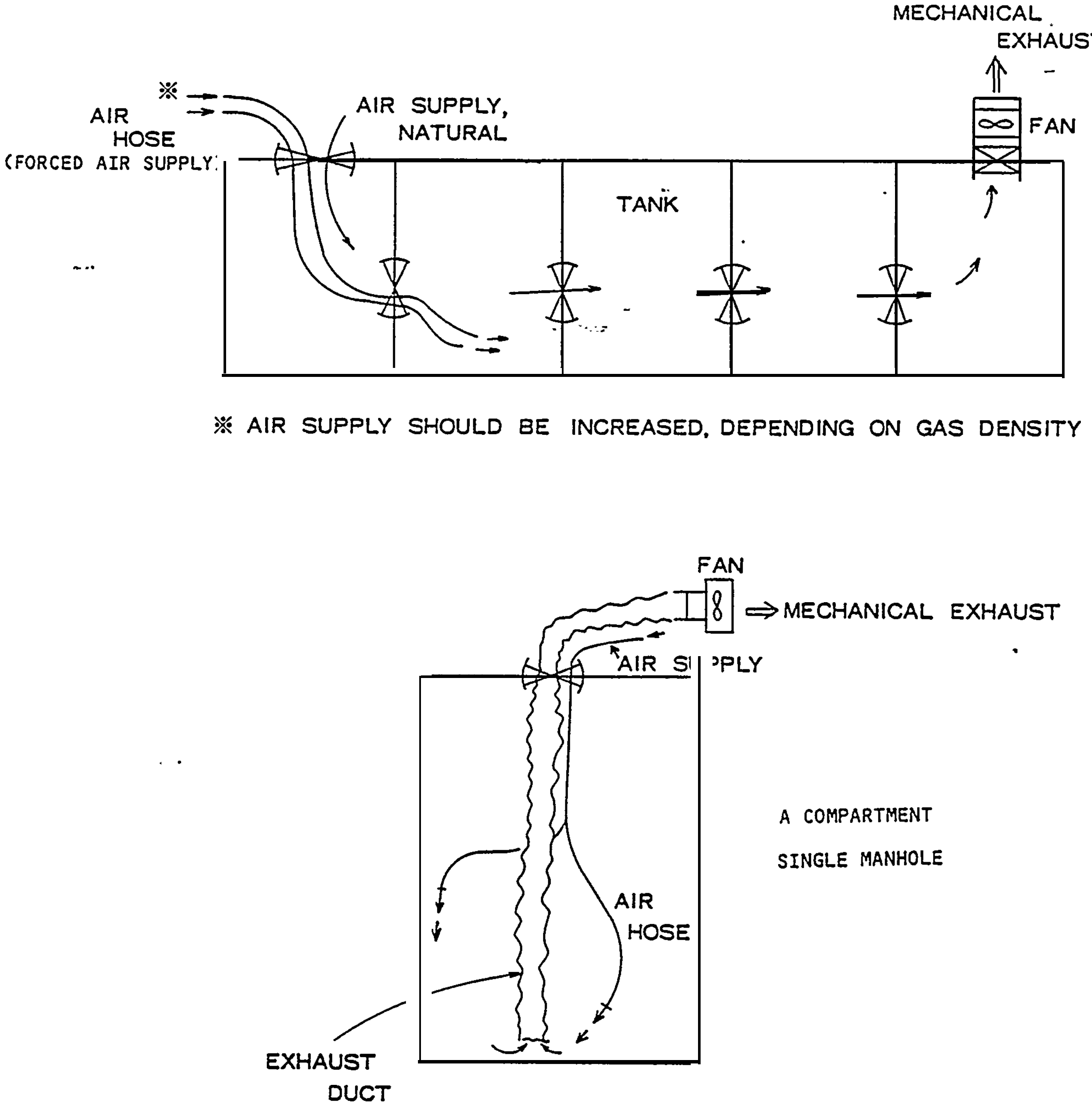


Figure 7-3: Examples of Ventilation Arrangement

- When two or more spray guns are used in one compartment, the capacity or number of ventilation fans should be increased to match the quantity of the paint sprayed.

2) Planning for Lighting:

Lighting for painting is very important in considering worker's safety, paint quality, and work efficiency. The arrangement of explosion proof lights should be determined by examining the hull structure and the scaffolding plan of each compartment. The lighting should be planned with the following considerations:

a) The lighting should be planned for sufficient illumination to assure safe work and access ways. Generally, illumination of at least 70 luxes, is required for each compartment.

b) In compartments defined as a No. 1 danger grade (see Figure 6-4), explosion proof lights must be adopted.

c) In principal, it is desirable to use fixed lights fitted on the ship. However, if fixed lights are not available, portable explosion proof lights may be used.

3) Planning for Scaffolding:

The scaffolding for painting is usually combined with work stages for hull construction or outfitting. However, if a lot of scaffolding is required just for painting, the following should be planned at the early stages of production:

- Preparation of scaffolding materials.

- Methods to install andlor remove the scaffoldings.
- Determine the timing to install/remove the scaffolding.
- Man-hours estimation for the scaffolding work.

It is especially important to determine the best timing for installing and removing the scaffolding. Accordingly, this should be scheduled at the planning -stage, and well coordinated with other work. The types of scaffolding utilized in painting are as follows:

- Frame stage
- Bitty type rolling tower
- Crane lighting type gondola
- Boson’s chair type painting stage
- Working car with lifting boom for high places.

Suitable scaffolding should be selected to match the work or paint zone. However, the most important thing is to minimize scaffolding requirements by careful planning so that the paint procedure can be shifted to the on-block stage. Figure 7-4 shows a working car with a working platform on the lifting boom to paint high places.

7.1 Overlap Coating:

As many kinds of paints are used on a ship, there are some restrictions in overlapping coating of different paints. It is necessary to study the contents of the base paint and the overlapping paint to prevent such defects as “Wrinkling” , “Aligatoring”, and “Lifting”. Special attention should be paid when overlapping different paint manufacturer’s products. The suppliers should provide the required information in determining the compatibility of the different paint products.

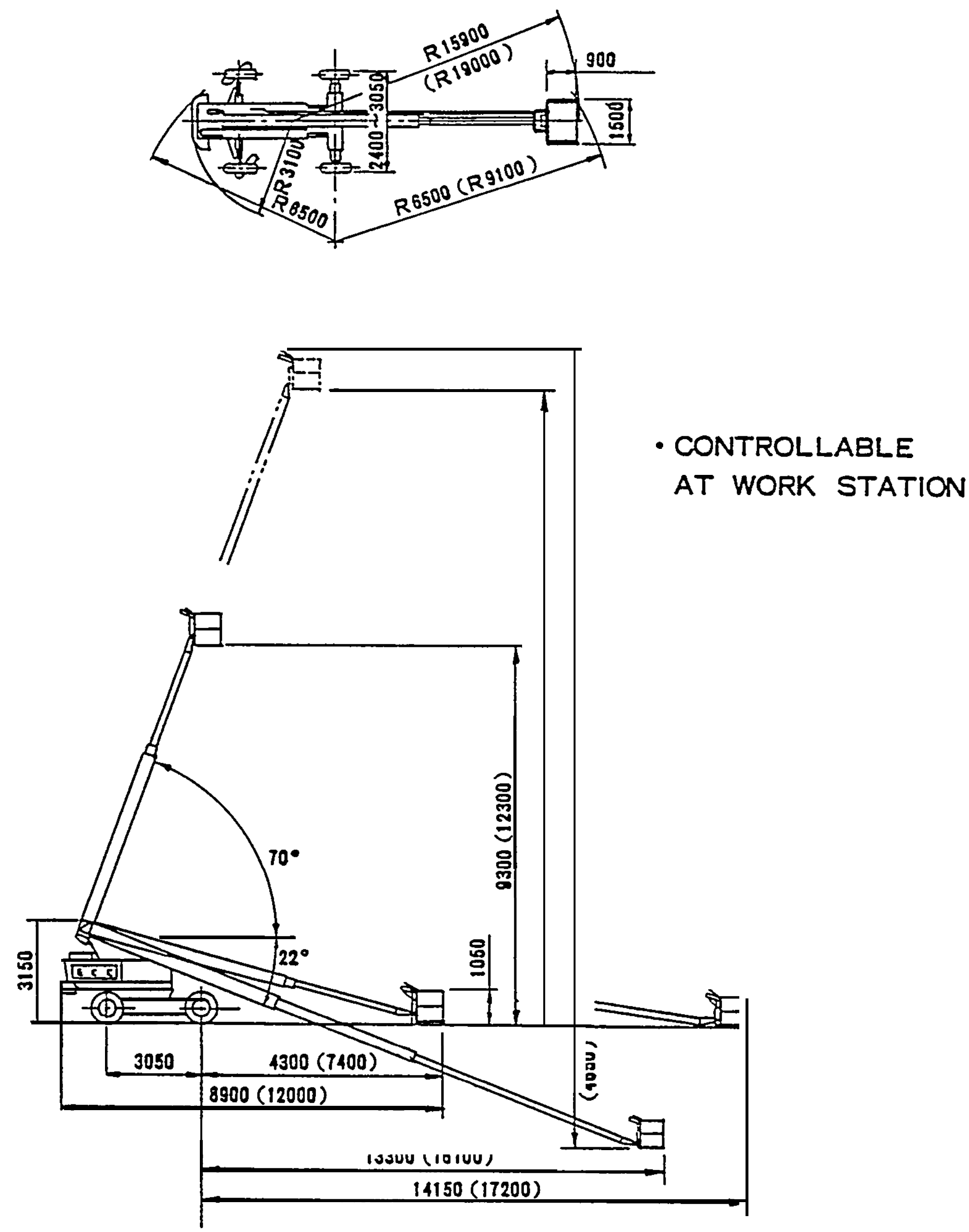


Figure 7-4: Diagram of a Working Car

Figure 7-5 is a compatibility list of the base coat and the overlap coat by seven different types of paint. In applying overlap coating, the following precautions should be taken:

- An interval of 24 hours or more is required to overlap other overcoat paints on alkali-silicate inorganic zinc base paint.
- A sufficiently long interval should be taken before overcoating inorganic zinc to insure it is cured. If not, poor adhesion of the top coat will result.
- White corrosion products may occur on inorganic zinc if too long an interval is taken before overcoating. If this occurs, remove by power brush, sand paper or disc sanding, before overcoating.
- When inorganic zinc is top coated, pin-holes in the top coat may occur. This is caused by trapped air. This can be minimized by applying a mist coat thinned 20% with thinner.
- When inorganic zinc is used as an undercoat or primer, vinyl or epoxy resin paint can be directly overcoated. However., oil based paint or chlorinated rubber paint must be coated after applying a tie coat.

Figure 7-6 shows two coating systems used on painting the shell of a ship. One requires overlapping of a tar epoxy paint with a chlorinated rubber paint, the other requires the overlapping of a coal tar epoxy with an epoxy paint.

7.2 Painting of Fittings

Painting stages for fittings are planned so that on-board coating can be minimized. Generally, the following are taken into consideration in determining the painting stages for fittings:

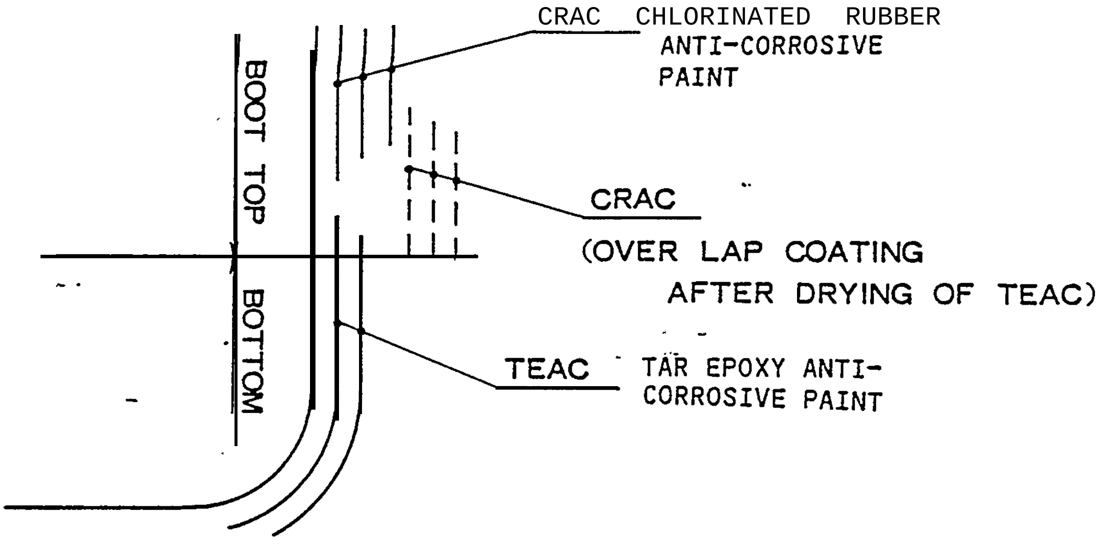
- Difficulty of painting work at 'the on-board stage, i.e., derrick posts and masts.

OVERCOAT PAINT / UNDERCOAT PAINT	OIL PAINT	ALKYD RESIN PAINT	CHLORINATED RUBBER PAINT	VINYL RESIN PAINT	PURE EPOXY PAINT	TAR EPOXY PAINT	PHENOL RESIN PAINT
OIL PAINT	○	×	×	×	×	×	○
ALKYD RESIN PAINT	△	○	△	△	×	×	△
CHLORINATED RUBBER PAINT	○	×	○	×	×	×	○
VINYL RESIN PAINT	○	○	△	○	×	×	○
PURE EPOXY PAINT	△	△	△	△	○	△	△
TAR EPOXY PAINT	△	△	△	△	△	○	△
PHENOL RESIN PAINT	○	△	△	×	×	×	○

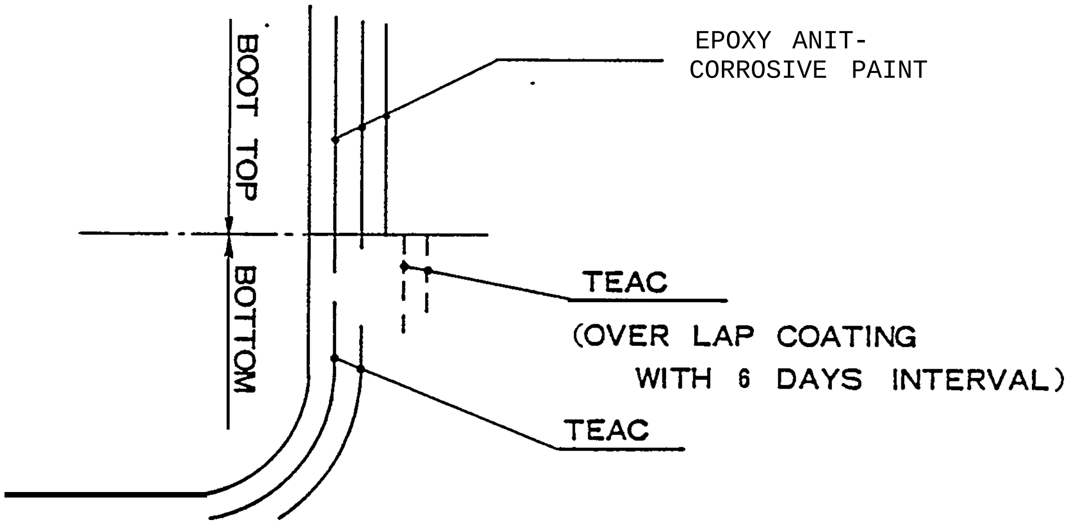
NOTES; ○ : COMPATIBLE × : NOT COMPATIBLE

△ : EXAMINE CAREFULLY WHETHER THE PAINTING CONDITION COMPLIES WITH THE REQUIREMENT OF EACH PAINT BRAND.

Figure 7-5: Compatibility of Overlap Coating



OVER LAP COATING OF TEAC AND CRAC



OVER LAP COATING OF TEAC AND EAC

Figure 7-6: Overlap Coating of Two Kinds of Paint Material

- Kind of paint material: i.e., fittings in cargo oil tanks requiring special coatings.
- Probability of damage during on-board work, or during outfitting.
- Fittings belonging to the compartment or zone where the final coat will be ‘applied at the on-board stage.

The following compartments or zones are planned for fins} coating during the on-board painting so as to avoid mechanical and cosmetic damage:

- Fresh water tanks
- Exposed decks, steering gear room decks
- Inside and outside of accommodation quarters
- Inside of engine room.

painting of each fitting is determined during the planning stage, and the painting specification for the fittings is issued by the design department.

7.3 Special Coatings

Product carriers or chemical tankers require a special cargo resistance type coating in their tanks, such as inorganic zinc silicate or epoxy resin materials, to prevent corrosion of tank structures and/or cargo contamination from rust.

For these special coatings, attention must be paid to avoid damage of the coating during construction. Therefore, on-block painting is not used for these coatings. When all construction and outfitting work inside the tanks is completed, surface preparation is carried out by abrasive blasting, then the tank is coated with the required number of coats of paint in a temperature-and humidity-controlled environment.

These sophisticated cargo resistant type coating systems are called "Special Coatings" among Japanese ship builders. In applying a special coating, intensive pre-planning and engineering is required at the early design stage. This planning includes the following:

1) Design Engineering:

a) Review of paint specifications to determine that the specified tank lining is compatible with the cargos to "be carried.

b) Design the hull structure to facilitate application and to insure coating quality. In order to facilitate surface preparation and coating, special attention should be paid to the following items:
   - Arrangement and shape of stiffeners.
   - Shapes of slots, drain holes and scallops.

c) The fitting arrangement and the way heating coils and other pipes are installed in the cargo oil tank should be designed to facilitate coating applications.

d) The small fittings materials should be selected to ensure their compatibility with the cargo and coating systems.

e) The arrangement of lugs and pieces, which are required for production work such as lifting eye-pieces for hull blocks and permanent scaffolding supports , should be carefully designed and planned during the design phase.

2) Paint Production Engineering:

a) Development of manufacturing methods:
The feasibility of each proposed manufacturing method and procedure should be carefully studied and evaluated in detail. Poor planning results in

unexpected obstruction and problems during production to disrupt the whole production schedule. This would result in poor productivity, more damage and rework. The following items should be carefully planned by production engineering:

- Working methods and work sites which meet the specific requirements of the special coating system.
- Special work packages, such as temperature afid humidity control, should be taken into consideration in the man hour estimation.
- Quality of workers:

  Worker’s skill and quality of workmanship.

  Man hours required for each task.

c Sequencing and scheduling:

  The proper sequence of work, including scaffolding, is the most important factor to maintain the working schedule.

  Work scheduling and its coordination with other trades, such as outfitting and hull construction, must be planned in detail.

b) Coordination with engineering design:

The following items are planned by the paint production engineers and are coordinated with design engineering:

- Location of lug pieces for scaffoldings.
- Location of temporary access holes.
- The production impact on fitting arrangements.
- Required drawing issue dates, to match the production schedule.

c) Protection of fittings:

Methods must be developed to protect fittings during scaffolding and sand blasting.

d) Plans to control the following environment conditions must be developed: .

- Humidity

- Atmospheric temperature
- Ventilating, etc.

e) Coating plan:
Specialized cargo liner coatings have very critical overcoat and curing times. These are dependent on the ambient temperature and humidity conditions. Therefore, in coating large tanks, the sequencing of areas to be worked is very important to the overall productivity of the job--

Painting processes of special coating varies depending upon the square feet of the area to be coated, the quality of coating to be applied and scheduling. Figure 7-7 shows an example of the process used to apply a “special coating”- to a large cargo tank, which is divided into two zones the upper and lower sections “of the tank.

7.4 Painting at Final Docking

Painting at final docking is mainly on the outside shell. Figure 7-8 shows a procedure for final coating in the dock. The process flow and descriptions are as follows:

1) Top Side Painting:
- Water washing of all surfaces to be painted is carried out by a water jet with a pressure of 50 to 60 kg/cm^2, keeping the distance between the jet nozzle and the coating surface at about 2 meters.
- Deck scuppers should be plugged with wood plugs or cloth tape before starting to paint.
- Burnt areas should be derusted by disc sander and touched up with 2 coats of anti-corrosive paint and one coat of top side paint before applying the final top side coat to the whole area. The first touch up coat is painted by roller brushes, and the succeeding coats are coated by spraying.

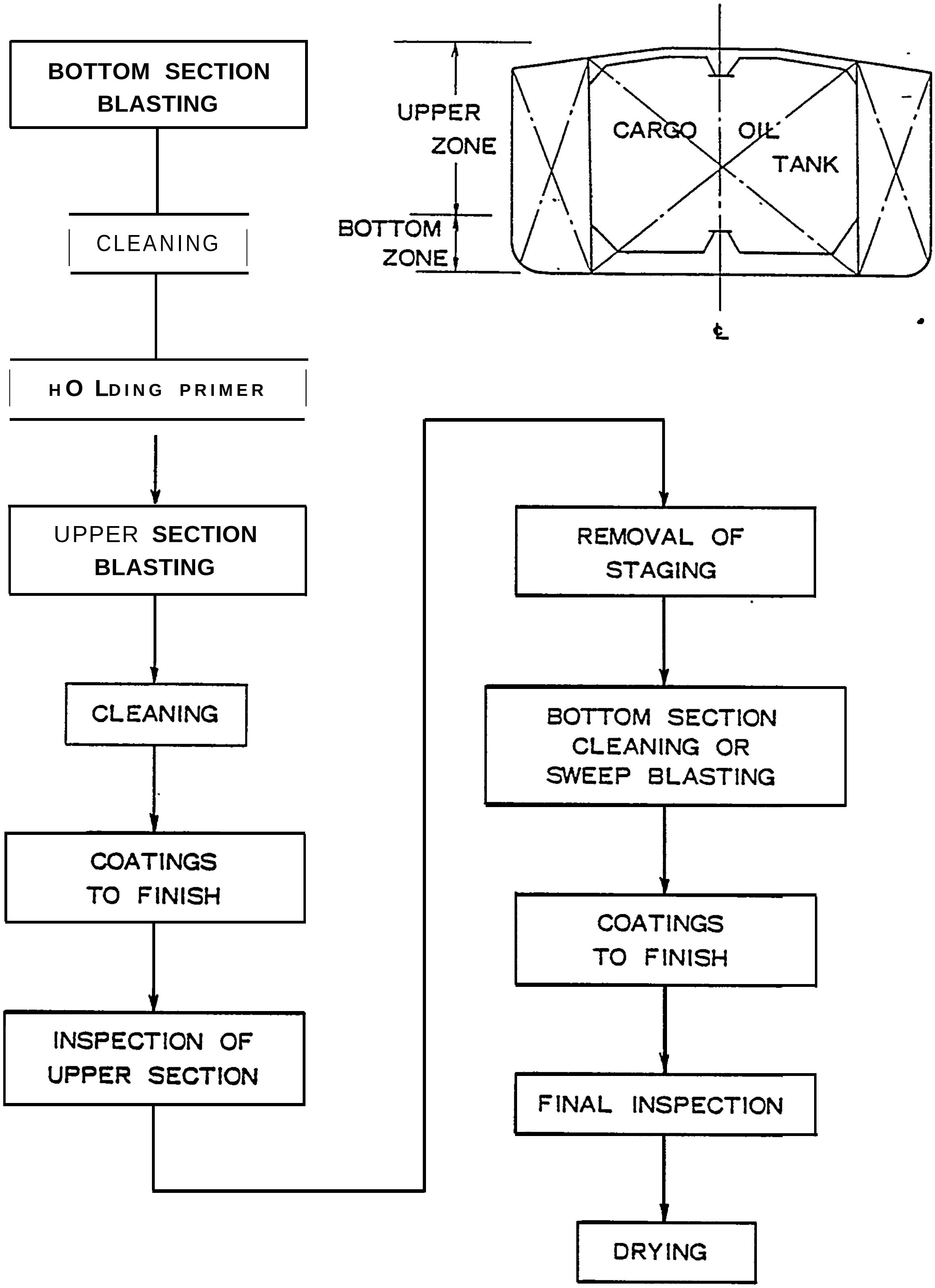


Figure 7-7: Special Coating Process

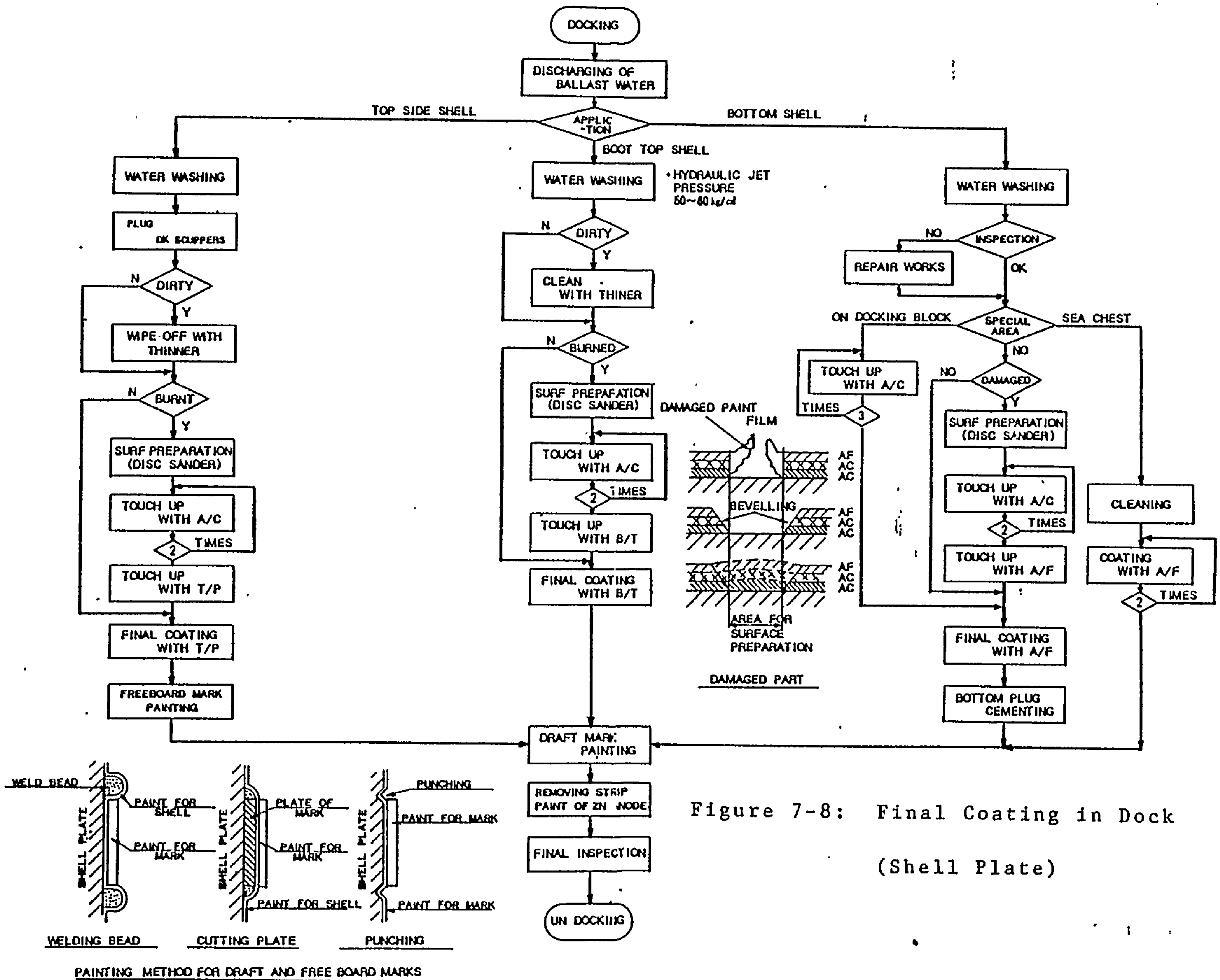


Figure 7-8: Final Coating in Dock

(Shell Plate)

- Dirt, such as oil, grease, etc. , should be **wiped** off with thinner.
- After the top side paint has dried, the ship's nam-e, bow mark, freeboard marks, draft marks, etc., ar e painted by brushes.

2) Boot Top Painting

- Water washing is done by the procedure **previously** described for the top side shell. Oily areas arounad the water line must be cleaned using thinner and clean cloths.
- Burnt and damaged areas are repaired as previously described., for the top side shell.
- After the boot top paint has dried, draft marks, etc., are painted.

3) Bottom Shell Painting

- After drying of the dock, high pressure water washing of the bottom shell is completed. If the surface is not clean and dry, the paint will not dry quickly. Additionally, problems may be experiences in. maintaining a homogeneous film thickness on the final coat of anti-fouling paint . The coating interval between water washing and overcoating should be at least 5 hours in summer and 24 hours in winter.
- If repairs are required after the final inspection, these repairs should be completed before leaving the dock.
- Damaged areas should be carefully treated with a disc sander, and the following coatings should be applied:

  Burnt and damaged areas should be touchedu with three coats of anti-corrosive paint.

Areas under the docking blocks should be touched up with two coats of anti-corrosive paint and one intermediate anti-fouling coat.

Then the anti-fouling paint is applied to the whole bottom area. A minimum of 8 hours is required after completion of the final coating before undocking.

- Inside surfaces of seachests should be cleaned and coated with the final coat of anti-fouling paint. After completing the coating application, the masking material is removed from the anode.
- Bottom plugs are cemented.
- Final inspection is made before undocking to insure that the paint is dry.

7.5 Inspection

Inspection of paint is an important factor to assure good paint performance. Inspection practices and acceptance criteria should be standardized to avoid confusion and trouble at the inspection site. It is advisable to establish these inspection methods and procedures as shipyards standards to which the ship owner has concurred.

Figure 7-9 shows an example of practical inspection criteria for the final painting. Visual inspection criteria are defined in detail for each ship area.

The dry film thickness should be carefully determined. Figure 7-10 details by which process stage the dry film thickness is determined. Dry film thickness requirements are as follows:

- Total film thickness is measured after completing the application of the anti-corrosive paint or after the application of the final coat, depending upon ship area. No measurement is required for interim coats.

ITEM	SURFACE GRADE OF FINAL COAT
BRIDGE FRONT WALL CABINS AND PASSAGES, WHERE APPEARANCE IS SPECIALLY IMPORTANT	1. VISUALLY INSPECT FOR SPOTTING, SAGGING, FEATHERING, WRINKLING, UNCOATED SPOTS, ETC. 2. COLOR OF THE FINAL COAT SHOULD MATCH THE SPECIFIED COLOR AND BLEND WITH THE SURROUNDING AREAS. 3. EXCESSIVE FOULING SHOULD NOT BE PRESENT. 4. EXCESSIVE OVERSPRAY IS NOT PERMITTED.
FOR VISIBLE AREAS, OTHER THAN THE ABOVE, SUCH AS INSIDE OF ENGINE ROOM, OUTSIDE OF SHELL, EXPOSED DECKS AND DECK STORES	1. SPOTTING, ALIGATORING, UNCOATED SPOTS, ETC., SHOULD NOT BE VISIBLE TO UNAIDED EYE. 2. SAGGING SHOULD NOT BE EXCESSIVE. 3. THE COLOR OF THE FINAL COAT SHOULD NOT BE EXCESSIVELY DIFFERENT FROM THE SPECIFIED COLOR.
FOR INVISIBLE PARTS, SUCH AS TANKS, HOLDS VOID SPACES AND COFFERDAMS	1. SPOTTING, ALIGATORING, UNCOATED SPOTS, ETC., SHOULD NOT BE VISIBLE TO UNAIDED EYE. 2. SAGGING SHOULD NOT BE EXCESSIVE, AND SHOULD NOT COVER A LARGE AREA. 3. PIN HOLES SHOULD NOT BE VISIBLE TO UNAIDED EYE. NO EXCESSIVE OVERSPRAY.

Figure 7-9: Final Coat Inspection Criteria

KIND OF PAINT / TIMING / LOCATION	INORGANIC ZINC PAINT OR EPOXY RESIN PAINTS		CONVENTIONAL PAINTS, E.G., OLEORESINOUS SYNTHETIC PAINTS, CHLORINATED RUBBER PAINTS, ETC.
	AFTER ANTI-CORROSIVE PAINTING	AFTER FINAL COATING	AFTER ANTI-CORROSIVE PAINTING
BOTTOM SHELL	○		○
SIDE SHELL	○		
EXPOSED PART OF UPPER DECK	○		
CARGO OIL TANK		○	
BALLASTWATER TANK		○	
FRESH WATER TANK		○	

Figure 7-10: Measuring Time to Inspect Dry Film Thickness

- No measurement should be taken at areas of about 15 mm from an edge or a welding bead. Additionally, no measurement should be made on a surface where t-he measurement is difficult or impractical, due to the arrangement of fittings or curvature of the surface.
- The film thickness should not be less than the require'd value for any single measurement.
- Thickness measurements should be taken at a rate of one spot per each $20m^2$ in tanks.
- If the final coat of paint is applied on-block, the film thickness may be taken at that time , but "possible shrinkage due to complete curing must be taken into account. The amount of shrinkage experienced is different for each coating.

APPENDIX A:

CLASSIFICATION OF MARINE PAINTS

CLASSIFICATION	GENERAL NAME OF PAINT	COMPOSITION OF PAINT				USAGE
		ELEMENTS OF PAINT FILM				
		VEHICLE SOLID	PIGMENT	ADDITIONAL CHMICALS	SOLVENT	
SHOP PRIMER	WASH PRIMER	VINYL BUTYL RESIN	ZINC CHROMATE CHROMIUM PHOSPHATE LEAD CHROMATE	PHOSPHATE ALCOHOL	ALCOHOL TYPE COALTAR TYPE	PRE TREATMENT PRIMER ON BLAST CLEANED STEEL PLATE
SHOP PRIMER	ZINC EPOXY PRIMER	EPOXY RESIN	ZINC POWDER ALUMINUM POWDER IRON OXIDE	TWO COMPONENT MATERIAL (BASE NEADER)	ESTEL, KETONE ETHAL, COAL TAR ALCOHOL	〃
SHOP PRIMER	EPOXY PRIMER (NON ZINC PRIMER)	〃	IRON OXIDE ALUMINUM POWDER	〃	〃	〃
SHOP PRIMER	INORGANIC ZINC PRIMER	SODIUM SILICATE ALKYL SILICATE	ZINC POWDER	DRIER ANTI PRECIPITATOR	WATER ALCOHOL COALTAR TYPE	〃
OIL BASIC TYPE — ANTI CORROSIVE PAINT :	GENERAL ANTI-CORROSION PAINT	DRYING OIL PHTHALATE RESIN	IRON OXIDE ZINC OXIDE BODY PIGMENT	DRIER	PETROLEUM TYPE COALTAR TYPE	RUST PREVENTING FOR INTERIOR AND EXTERIOR
OIL BASIC TYPE — ANTI CORROSIVE PAINT :	ANTI-CORROSION PAINT OF MINIUM	〃	MINIUM BODY PIGMENT	〃	〃	〃
OIL BASIC TYPE — ANTI CORROSIVE PAINT :	ANTI-CORROSION PAINT OF LEAD SUBOXIDE	〃	LEAD SUBOXIDE COLOUR PIGMENT BODY PIGMENT	〃	〃	〃

CLASSIFICATION		GENERAL NAME OF PAINT	COMPOSITION OF PAINT: ELEMENT OF PAINT FILM: VEHICLE SOLID	PIGMENT	ADDITIONAL CHEMICALS	SOLVENT	USAGE
OIL BASIC TYPE	ANTI-CORROSION TYPE	ANTI - CORROSION PAINT OF LEAD CHROMATE	DRYING OIL PHTHALATE RESIN	LEAD CHROMATE COLOUR PIGMENT BODY PIGMENT	DRIER	PETRO LEUM TYPE COAL TAR TYPE	RUST PREVENTING FOR INTERIOR AND EXTERIOR
		ANTI - CORROSION PAINT OF CALCIUM PLUMBATE	〃	CALCIUM PLUMBATE COLOUR PIGMENT BODY PIGMENT	〃	〃	〃
		ANTI - CORROSION PAINT OF MINIUM, ZINC CHROMATE	DRYING OIL PHTHALATE RESIN PHENOL RESIN	MINIUM ZINC CHROMATE COLOR PIGMENT BODY PIGMENT	〃	〃	〃
		ANTI - CORROSION PAINT OF MINIUM, ZINC CHROMATE, IRON OXIDE	〃	MINIUM ZINC CHROMATE IRON OXIDE BODY PIGMENT	〃	〃	〃
	OUTER SHELL PAINT	ANTI - CORROSION PAINT	DRYING OIL PHENOL RESIN	IRON OXIDE ALUMINUM POWDER BODY PIGMENT	〃	〃	RUST PREVENTING FOR BOTTOM AND BOOT TOP ZONE
		ANTI - FOULING PAINT	DRYING OIL PHENOL RESIN	TOXICITIC PIGMENT (CUPROUS OXIDE) IRON OXIDE BODY PIGMENT	ANTI PRECIPITATOR DRIER	〃	EFFECTIVE PROTECTION AGAINST FOULING FOR BOTTOM
		BOOT TOPPING PAINT	DRYING OIL PHENOL RESIN	COLOUR PIGMENT BODY PIGMENT	〃	〃	FINISH PAINT FOR BOOT TOP

CLASSIFI-CATION	GENERAL NAME OF PAINT	COMPOSITION OF PAINT: ELEMENTS OF PAINT FILM: VEHICLE SOLID	PIGMENT	ADDITIONAL CHEMICALS	SOLVENT	USAGE
OIL BASIC TYPE	OUTER SHELL PAINT: TOP SIDE PAINT	DRYING OIL PHTHALATE RESIN	COLOUR PIGMENT BODY PIGMENT	ANTI-PRELIPITATOR DRIER	PETROLEUM TYPE COAL-TAR TYPE	FINISH PAINT FOR TOP SIDE
	DECK PAINT	DRYING OIL PHTHALATE RESIN	IRON OXIDE ZINC OXIDE BODY PIGMENT	〃	〃	DECK PART
	HOLD PART	〃	IRON OXIDE ZINC OXIDE BODY PIGMENT	〃	〃	HOLD PART
		DRYING OIL PHENOL RESIN	ZINC OXIDE TITANUM OXIDE	〃	〃	
	FINISH PAINT FOR MARINE	DRYING OIL PHENOL RESIN	ALMINUM POWDER BODY PIGMENT	〃	〃	SUPERSTRUCTURE ENGINE ROOM ETC.
VINYL RESIN TYPE	ANTI-CORROSION PRIMER	VINYL ACETATE VINYL CHLORIDE	MINIUM IRON OXIDE BODY PIGMENT	PLASTICIZER STABILIZER	COAL-TAR KETONE ALCOHOL	SUPERSTRUCTURE
			MINIUM ZINC CHROMATE BODY PIGMENT			
	ANTI-CORROSION PAINT	〃	ALUMINUM POWDER (IRON OXIDE)	〃	〃	OUTER SHELL
	ANTI-FOULING PAINT	〃	TOXICITIC OXIDE (CUPROUS OXIDE) IRON OXIDE	〃	〃	EFFECTIVE PROTECTION A GAINST FOULING FOR BOTTOM

CLASSIFI-CATION	GENERAL NAME OF PAINT	COMPOSITION OF PAINT				USAGE
		ELEMENTS OF PAINT FILM				
		VEHICLE SOLID	PIGMENT	ADDITIONAL CHEMICALS	SOLVENT	
VINYL RESIN TYPE	BOOT TOPING PAINT	VINYL ACETATE VINYL CHLORIDE	COLOUR PIGMENT BODY PIGMENT	PLASTICIZER STABILIZER	COAL-TAR KETONE ALCOHOL .	BOOT TOP ZONE
	FINISH PAINT FOR MARINE	〃	〃	〃	〃	SUPERSTRUCTURE TOP SIDE ZONE OTHER PART ETC.
EPOXY RESIN TYPE	ANTI-CORROSION PRIMER	EPOXY RESIN	MINIUM IRON OXIDE BODY PIGMENT	DRIER POLY AMIDE RESIN	ESTEL KETONE ETHAL COAL-TAL ALCOHOL	RUST-PREVENTING FOR SUPERSTRUCTURE ETC.
		〃	ALUMINUM POWDER IRON OXIDE BODY PIGMENT	〃	〃	RUST-PREVENTING FOR OUTER SHELL
	FINISH PAINT FOR MARINE	〃	COLOUR PIGMENT BODY PIGMENT	〃	〃	FINISH PAINT OF INTERIOR AND EXTERIOR
TAR EPOXY PAINT		EPOXY RESIN COAL-TAR	ALUMINUM POWDER	〃	〃	IN TANK OUTER SHELL (EXCEPT TOP SIDE) OIL-PREVENTING

CLASSIFI-CATION	GENERAL NAME OF PAINT	COMPOSITION OF PAINT				USAGE
		ELEMENT OF PAINT FILM				
		VEHICLE SOLID	PIGMENT	ADDITIONAL CHEMICALS	SOLVENT	
CHLORINATED RUBBER TYPE	ANTI-CORROSION PRIMER	CHLORINATED RUBBER	MINIUM IRON OXIDE BODY PIGMENT	PLASTICIZER STABILIZER	PETROLEUM TYPE COAL-TAR TYPE	RUST-PREVENTING FOR SUPERSTRUCTURE ETC.
		〃	MINIUM ZINC CHROMATE BODY PIGMENT	〃	〃	
		〃	ALUMINUM POWDER BODY PIGMENT	〃	〃	RUST-PREVENTING FOR OUTER SHELL
	ANTI-FOULING PAINT	〃	TOXICITIC PIGMENT (CUPROUS OXIDE) IRON OXIDE BODY PIGMENT	〃	〃	EFFECTIVE PROTECTION AGAINST FOULING FOR BOTTOM
	BOOT-TOPPING PAINT	〃	COLOUR PIGMENT BODY PIGMENT	〃	〃	FINISH PAINT FOR BOOT TOP ZONE
	FINISH PAINT FOR MARINE	〃	〃	〃	〃	FINISH PAINT FOR TOP SIDE ZONE, SUPER-STRUCTURE AND DECK ETC.
POLYURETHANE RESIN TYPE	POLYURETHANE RESIN	POLY URETHANE RESIN	COLOUR PIGMENT BODY PIGMENT	DRIER	ESTEL, ETHAL KETONE COAL-TAR TYPE	RUST-PREVENTING FOR IN TANKS
	TAR-URETHANE	〃	ALUMINUM POWDER	〃	〃	〃

CLASSIFI-CATION	GENERAL NAME OF PAINT	COMPOSITION OF PAINT				USAGE
		ELEMENT OF PAINT FILM				
		VEHICLE SOLID	PIGMENT	ADDITIONAL CHEMICALS	SOLVENT	
ZINC RICH PAINT	ORGANIC ZINCRICH PAINT	POLYSTYRENE RESIN	ZINC POWDER BODY PIGMENT	ANTI-PRECIPITATOR	COAL-TAR TYPE	RUST-PREVENTING FOR INTANKS ETC
		EPOXY RESIN	〃	DRIER	ESTER, ETHAL KETONE COAL-TAR TYPE	
		CHLORINATED RUBBER	〃	PLASTICIZER STABILIZER	PETROLEUM TYPE COAL-TAR TYPE	
	INORGANIC ZINC RICH PAINT	SODIUM SILICATE	〃	DRIER	WATER	RUST-PREVENTING FOR INTANKS AND OUTER SHELL
		ALKYL SILICATE	〃	ANTI-PRECIPITATOR	ALCOHOL COAL-TAR TYPE	RUST-PREVENTING FOR INTANKS ETC
	BITUMINOUS PAINT	BITUMINOUS MATERIAL PHENOL RESIN CHLORINATED RUBBER	ALUMINUM POWDER	DRIER	PETROLUM TYPE COAL-TAR TYPE	CHAIN ETC
	HEAT RESISTANT PAINT	SILLICON RESION PHTHALATE RESION	ALUMINUM POWDER BODY PIGMENT	〃	PETROLUME TYPE COAL-TAR TYPE	RUST-PREVENTING FOR STEAM PIPE
		ALKYLTITANATE	〃	〃	〃	〃

APPENDIX B:

JAPANESE MARINE PAINT PRODUCTS

(BY 3 MANUFACTURERS)

APPLICATION	SYMBOL	KIND OF PAINT \ ITEM \ MAKER	NIPPON PAINT CO., LTD.			C+UCCKU MWIINE PAINT Co,,'LTD.			KANSAI PAINT CO.. LTD.		
			PAINT NAME			PAINT NAME			PAINT NAME		
			COLOUR	DRY FILM THICKNESs	COVERAGE (THEORITICALI	COLOUR	DRY FILM THICKNESS	COvERAGE [THEC+UTICAL1	COLOUR	CRY FILM THICKNESS	CWERAGE (TIWORITICALI
SHOP PRIMER	WP	WASH PRIMER	VINILEX 120 ACTIVE PRIMER			EVABOND NC-F			METALACT H- 15		
			IARK GREEN	12 p	90 9/nt	GREYISH BLUE GREEN RECOISH BIWINN	15 II	111 9/nf	DARK GREEN	15 B	Q 3 9/ni
	NZP	NON ZINC PRIMER	ZINCFREE SHOP PRIMER			NZ PRIMER-S			SD NON ZINC PRIMER		
			GREEN	20 μ	134 9/nt	REDDISH BROWN	22 μ	107 9/nt	OXIDE RED	20 μ	86 9/nt
	ZP	ZINC EPOXY PRIMER	NIPPE ZINKY 1000P			EPICON ZINC RICH PRIMER B-2			SD ZINC PRIMER ZE NO 100		
			GRAY	15 II	63 9/ni	GREEN	18 P	95 9/d	GREY	15 II	90 9/nt
	IZP	INORGANIC ZINC PRIMER	NIPPE ZINKY 1000 FZ			I WELBOND H			ISD zINC PRIMER ZE NOIOOOHA.		
			3REEN, GRAY BROWN	15 μ	85 9/nt	DARK GREEN DARK BROWN	15 μ	79 9/nt	GREY, GREEN OXIDERED	15 μ	60 9/nt
	GP	SALVANIC PRIMER	VINILEX 110 ACTIVE PRIMER			GALVANITE NO 200 PRIMER			SD MARINE CP PRIMER		
			LEMON YELLCW	7 P	89 9ht	bM+ITE	20 JI	80 9hi	WIiITE	35 #	04 9/nt
SHELL PLATE PAINT / ANTI CORROSIVE PAINT	CAC	CHLORINATED RUBBER 4NTI CORROSIVE P	RABACOAT A ZC			RAVAX ANTI CORROSIVE-HE			RABAW.RINE SILVER TONE HD		
			SILVER LIGHT BROWN	40 μ	118 9/nt	REDDISH SILVER PINKISH SILVER	65 μ	210 9/nt	DARK REDDISH SILVER	70 μ	212 9/nt
	EAC	EPOXY 4NTI CORROSIVE P	NIPPE EPOXY PRIMER			EPICON MARINE HE-AL			EPOMARINE A/C S		
			RED OXIDE GRAY	100 μ	316 9/nt	REDDISH SILVER SILVER	100 μ	205 9/nt	SILVER	100 μ	240 9/nt
	/TAC	JINYL TAR EPOXY ANTI CORROSIVE P	VINITAR A/C			SILVAX SQ			VINYLIA BTM		
			SILVER, BRONZE	75 μ	217 9/nt	SILVER BROWN	40 μ	105 9/nt	SILVER BROWN	85 μ	334 9/nt

APPLICATION		SYMBOL	KIND OF PAINT	NIPPON PAINT CO., LTD. PAINT NAME	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)	CHIKWW MARINE PAINT CO., LTQ PAINT NAME	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)	KANSA I PAINT CO. LTD. PAINT NAME	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)
SHELL PLATE PAINT	ANTI CORROSIVE	I_EAC	TAR EPOXY ANTI CORROSIVE P	EPOTAR M A/C	BLACK BROWN	100 µ	197 g/㎡	BISCON AC	BLACK BROWN	125 µ	260 g/㎡	EPOSEAL BTM	BLACK	125 µ	264 g/㎡
SHELL PLATE PAINT	ANTI FOULING PAINT	CAF	CHLORINATED RUBBER ANTI FOULING P	RABACOAT A/F	RED OXIDE	40 µ	131 g/㎡	RAVAX ANTI-FOULING	DARK REDDISH BROWN	45 µ	135 g/㎡	RABAMARINE A/F	OXIDE RED	40 µ	137 g/㎡
SHELL PLATE PAINT	ANTI FOULING PAINT	EAF	EPOXY ANTI FOULING P	———		µ	g/㎡	EPICON MARINE ANTI-FOULING	REDDISH BROWN	50 µ	220 g/㎡	EPOMARINE A/F (E)	OXIDE RED	40 µ	152 g/㎡
SHELL PLATE PAINT	ANTI FOULING PAINT	VAF	VINYL ANTI FOULING P	VINILEX 2730 A/F	RED OXIDE	40 µ	130 g/㎡	CHUGOKU VINYL ANTI-FOULING	REDDISH BROWN	45 µ	220 g/㎡	VINYLIA A/F	OXIDE RED	40 µ	163 g/㎡
SHELL PLATE PAINT	ANTI FOULING PAINT	LLAF	LONG LIFE ANTI FOULING P	NIPPE HI-SPEED HLC	PINK, RED	75 µ	280 g/㎡	AF SEAFLO SP	REDDISH BROWN (LIGHT & DARK)	75 µ	275 g/㎡	RABAMARINE A/F NO 1000	OXIDE RED	60 µ	219 g/㎡
SHELL PLATE PAINT	ANTI FOULING PAINT	SPAF	SELF POLISHING TYPE ANTI FOULING P	SPC-9	PLUM, PINK RED	100 µ	386 g/㎡	AF SEAFLO Z100	LIGHT BROWN DARK BROWN	100 µ	385 g/㎡	RABAMARINE AF NO 2500	RED, LIGHT	100 µ	388 g/㎡
SHELL PLATE PAINT	BOOT TOP PAINT	CBT	CHLORINATED RUBBER BOOT TOP P	RABACOAT FINISH	AS SPECIFIED	30 µ	90 g/㎡	RAVAX BOOTTOPPING	REDDISH BROWN AS SPECIFIED	35 µ	105 g/㎡	RABAMARINE B/T	OXIDE RED AS SPECIFIED	35 µ	134 g/㎡
SHELL PLATE PAINT	BOOT TOP PAINT	EBT	EPOXY BOOT TOP P	NIPPE EPOXY FINISH	WHITE, BLACK AS SPECIFIED	40 µ	117 g/㎡	EPICON MARINE BOOT TOPPING UNDERCOAT	REDDISH BROWN AS SPECIFIED	60 µ	180 g/㎡	EPOMARINE B/T	OXIDE RED, GREEN	40 µ	120 g/㎡

APPLICATION		SYMBOL	KIND OF PAINT	NIPPON PAINT CO,LTD.				CItKfMJ MARINE PAINT CO., LTD.				KANSA I PAINT CO- LTD.			
				PAINT NAME	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)	PAINT NAME	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)	PAINT NAME	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)
SHELL PLATE PAINT	TOPSIDE PAINT	CTP	CHLORINATED RUB13ER TOPSIDE ‘P	RABACOAT FINISH	AS SPECIFIED	30 μ	90 g/m²	RAVAX TOPSIDE	BLACK AS SPECIFIED	35 μ	95 g/m²	RABAMARINE TOPSIDE PAINT	BLACK, WHITE AS SPECIFIED	35 μ	120 g/m²
SHELL PLATE PAINT	TOPSIDE PAINT	ETP	EPOXY TOPSIDE P	NIPPE EPOXY FINISH	WHITE, BLACK AS SPECIFIED	40 μ	117 g/m²	EPICON MARINE TOPSIDE UNDERCOAT	BLACK AS SPECIFIED	60 μ	175 g/m²	EPOMARINE TOPSIDE PAINT	BLACK, WHITE AS SPECIFIED	40 μ	116 g/m²
ANTI RUST PAINT		LZ	LEAD ZINC CHROMATE PRIMER	LZ PRIMER	RED OXIDE	35 μ	105 g/m²	LZI PRIMER	REDDISH BROWN DARK RED LEAD	40 μ	120 g/m²	SD MARINE PRIMER L	ORANGE	35 μ	112 g/m²
ANTI RUST PAINT		WRP	WHITE RUST RESISTING PAINT	CR MARINE WHIT PRIMER	WHITE	35 μ	101 g/m²	ROSWAN QD	WHITE	40 μ	125 g/m²	SD MARINE WHITE PRIMER	WHITE	35 μ	89 g/m²
ANTI RUST PAINT		CPP	CHLORINATED RUBBER PRIMER PAINT	RABACOAT PRIMER	RED LEAD, BROWN LIGHT GRAY	40 μ	134 g/m²	RAVAX RED LEAD PRIMER	ORANGE REDDISH·BROWN	40 μ	140 g/m²	RABAMARINE BROWN PRIMER	BROWN DARK BROWN	35 μ	114 g/m²
ANTI RUST PAINT		EPP	EPOXY PRIMER PAINT	NIPPE EPOXY PRIMER	RED OXIDE GRAY	100 μ	316 g/m²	EPICON MARINE AC-CL	REDDISH ORANGE LIGHT ORANGE	50 μ	140 g/m²	EPOMARINE BROWN PRIMER	BROWN	60 μ	180 g/m²
FINISH PAINT		CP	FINISH PAINT	CR MARINE FINISH	WHITE AS SPECIFIED	30 μ	72 g/m²	EVAMARINE INTERIOR	WHITE AS SPECIFIED	30 μ	75 g/m²	SD MARINE PAINT	WHITE AS SPECIFIED	35 μ	84 g/m²
FINISH PAINT		CCP	CHOLINATED RUBBER FINISH PAINT	RABACOAT FINISH	RED OXIDE, WHITE AS SPECIFIED	30 μ	90 g/m²	RAVAX FINISH	WHITE AS SPECIFIED	35 μ	110 g/m²	RABAMARINE PAINT	WHITE AS SPECIFIED	35 μ	120 g/m²

APPLICATION	YMBOL	MAKER / ITEM / KIND IF\ PAINT	NIPPON PAINT CO., LTD.			CHUGOKU MARINE PAINT CO., LTD.			KANSAI PAINT CO., LTD.		
			PAINT NAME			PAINT NAME			PAINT NAME		
			COLOUR	CRY FILM THICKNESS	COVERAGE IWECMUTICAL>	COLOUR	DRY FILM THICXNESS	COVERAGE ITH=II!ITICAL)	COLOUR	G3Y FIIM THICKNESS	CDVERAGf ITUEOR8TICA1
FINISH PAINT	ECP	EPOXY FINISH PAINT	NIPPE EPOXY FINISH			EPICON MARINE FINISH			EPCMARINE PAINT		
			WHITE, BLACK AS SPECIFIED	40 μ	117 g/m²	WHITE AS SPECIFIED	40 μ	125 g/m²	WHITE AS SPECIFIED	35 μ	105 g/m
	UCP	URETHANE FINISH PAINT	POLYURE MIGHTYLAC-M			UNY MARINE			RETAN NO 6000 FINISH		
			WHITE LIGHT COLOURS	30 μ	94 g/m²	WHITE AS SPECIFIED	35 μ	80 g/m²	WHITE AS SPECIFIED	35 μ	99 g/m²
	CDP	CHLORINATED RUBBER DECK PAINT	RABACOAT FINISH			RAVAX DECK			RAEMMARINE DECK PAINT		
			AS SPECIFIED	30 μ	90 g/m²	REDDISH BROWN AS SPECIFIED	35 μ	115 g/m²	OXIDE RED, GREEN AS SPECIFIED	35 μ	134 g/m
	EDP	EPOXY DECK PAINT	NIPPE EPOXY FINISH			EPICON MARINE DECK			EPOMARINE DECK PAINT		
			WHITE, BLACK AS SPECIFIED	40 μ	117 g/m²	REDDISH BROWN AS SPECIFIED	60 μ	185 g/m²	OXIDE RED, GREEN AS SPECIFIED	40 μ	116 g/m²
	HRP	HEAT RESISTING PAINT	NIPPE TAINETSU 50			SILCON NO 400 SILVER			THERMO NO 300 SILVER		
			WHITE LIGHT CCLCNJRS	20 tt	64 9/nt	SILVER	15 P	50 9/d	SILVER	15 II	63 9/nl
TANK PAINT	TE	TAR EPOXY PAINT	EPOTAR M •HB			BISCON HB			EPOSEAL NO 6000 S		
			BLACK RED BRCXWJ	200 N	422 9/id	BLACK BRCWN	250 ıı	460 9/nt	BLACK	250 .U	526 9/ni
	BTE	BLEACHED TAR EPOXY P	EPOTAR M •NB			BISCON NO !000 NT			EPCMARINE EX NO 300		
			GRAY, SILVER LIGHT COLOURS	100 μ	218 g/m²	REDDISH BROWN LIGHT GRAY	125 μ	295 g/m²	GRAY OXIDE RED	200 μ	523 g/m²
	EP	EPOXY PAINT	ORGA 1000			EPICON T-500			EPOMARINE FW NO 100		
			WHITE, BLUE, CREAM	70 μ	206 g/m²	GRAY, WHITE LIGHT GRAY	75 μ	225 g/m²	OXIDE RED	80 μ	189 g/m²

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APPLICATION	SYMBOL	KIND OF PAINT	NIPPON PAINT CO., LTD.			CHUGOKU MARINE PAINT CO., LTD.			KANSAI PAINT CO., LTD.		
			PAINT NAME			PAINT NAME			PAINT NAME		
			COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)	COLOUR	DRY FILM THICKNESS	COVERAGE (THEORITICAL)
TANK PAINT	BS	BITUMEN SOLUSION				APERIA NO 3000			SD TAR ENAMEL QD		
				μ	g/m^2	BLACK	100 μ	270 g/m^2	BLACK	80 μ	211 g/m^2
	RPO	RUST PREVENTIVE OIL				RUST INHIBITIVE OIL "CK"					
				μ	g/m^2	CLEAR	20 μ	40 g/m^2		μ	g/m^2
	IZS	INORGANIC ZINC SILICATE PAINT	NIPPE ZINKY 1000M QC			GALBON S-HB			SD ZINK PRIMER ZE1500		
			GRAY	75 μ	355 g/m^2	GRAY	75 μ	330 g/m^2	GRAY	75 μ	325 g/m^2
				μ	g/m^2		μ	g/m^2		μ	g/m^2
				μ	g/m^2		μ	g/m^2		μ	g/m^2
				μ	g/m^2		μ	g/m^2		μ	g/m^2
				μ	g/m^2		μ	g/m^2		μ	g/m^2
				μ	g/m^2		μ	g/m^2		μ	g/m^2

APPENDIX C:

SAMPLE STANDARD PAINT SCHEME

(BULK CARRIER)

PAINTING AREA				GRADE OF DE-RUSTING		SHOP PRIMER	PAINT & NUMBER OF COAT					REMARK
				BEFORE SHOP PRIMER	BEFORE FIRST COATING		1	2	3	4	5	
SHELL	BOTTOM	KEEL AND BLOCKING AREA	BEFORE LAUNCHING	SP-10	SP-3	IZP	TEAC	TEAC -1	BC	CAF	CAF	TEAC: MIN. 250 MC IN TOTAL
			AT DOCKING									
		KEEL TO BALLAST LINE	BEFORE LAUNCHING				TEAC	TEAC -1	BC	CAF		
			AT DOCKING								CAF	
	BALLAST LINE TO DECK		BEFORE LAUNCHING	〃	〃	IZP	CAC	CAC	CTP			
			AFTER LAUNCHING							CTP		
	BOW CHOCK		OUTSIDE	〃	〃	IZP	CAC	CAC	CTP	CTP		
			INSIDE				CPP	CPP	CCP	CCP		
	RUDDER		OUTSIDE	〃	〃	IZP	TEAC	TEAC -1	BC	CAF	CAF	SAME AS BOTTOM
			INSIDE		SP-10		BS	BS				
	RUDDER TRUNK			〃	SP-3	IZP	TE	TE-1				
	INSIDE OF STERN FRAME			〃	〃	IZP	BS	BS				
DECK	UPPER DECK			〃	〃	IZP	CPP	CPP -1	CDP	CDP		
	DECK (EXCEPT ABOVE)			〃	〃	IZP	CPP	CPP -1	CDP	CDP		
	UNDER DECK MACHINERY			〃	〃	IZP	TE	TE				

PAINTING AREA					DE-RUSTING BEFORE SHOP PRIMER	DE-RUSTING BEFORE FIRST COATING	SHOP PRIMER	PAINT & NUMBER OF COAT 1	2	3	4	5	REMARK
SUPERSTRUCTURE & ACCOMODATION SPACE	EXTERIOR PARTS	DECK HOUSE	FRONT WALL OF BRIDGE		SP-10	SP-3	IZP	CPP	-1	CCP	CCP		
			UNDER SURFACE OF DODGER ON NAV. BRI. DK.					CPP	CPP -1	CCP	CCP		
			OTHER AREA					CPP	CPP	CCP	CCP		
	INTERIOR PARTS	PUBLIC ROOM LIVING ROOM OFFICE AND PASSAGE	CEILING AND WALL	STEEL	"	"	IZP	LZ	WRP	CP	CP		
				UNDER INSULATION				LZ	LZ-1				
			FLOOR	STEEL	"	"	IZP	LZ	LZ-1	DP	DP		
				UNDER COVERING				"NO COATING"					
		GALLEY AND SANITARY SPACE	CEILING	BARE STEEL	"	"	IZP	LZ	WRP	CP	CP		
				UNDER INSULATION				LZ	LZ-1				
			WALL	BARE STEEL	"	"	IZP	LZ	WRP	CP	CP		
				UNDER INSULATION				LZ	LZ-1				
			FLOOR	STEEL	"	"	IZP	LZ	LZ-1	DP	DP		
				UNDER COVERING				"NO COATING"					
DECK STORE (EXTERIOR PART)			TOP PLATE		"	"	IZP	CPP	-1	CDP	CDP		
			SIDE WALL					CPP	CPP	CCP	CCP		
BULWARK (INSIDE)					"								

PAINTING AREA				GRADE OF DE-RUSTING		SHOP PRIMER	PAINT & NUMBER OF COAT					REMARK
				BEFORE SHOP PRIMER	BEFORE FIRST COATING		1	2	3	4	5	
STORES	BOSUN'S STORE ENTRANCE	TOP PLATE		SP-10	SP-3	IZP	CPP	CPP -1	CDP	CDP		
STORES	BOSUN'S STORE ENTRANCE	SIDE WALL		SP-10	SP-3	IZP	CPP	CPP -1	CCP	CCP		
STORES	BOSUN'S STORE	CEILING		〃	〃	IZP	LZ	WRP	CP			SAME AS WORK SHOP BOTTLE SHOP LOCKER
STORES	BOSUN'S STORE	WALL		〃	〃	IZP	LZ	WRP	CP			SAME AS WORK SHOP BOTTLE SHOP LOCKER
STORES	BOSUN'S STORE	FLOOR		〃	〃	IZP	LZ	LZ-1	DP			SAME AS WORK SHOP BOTTLE SHOP LOCKER
STORES	DECK STORE PAINT STORE VALVE REMOCON STATION	CEILING & WALL	BARE STEEL	〃	〃	IZP	LZ	WRP	CP			
STORES	DECK STORE PAINT STORE VALVE REMOCON STATION	CEILING & WALL	UNDER INSULATION	〃	〃	IZP	LZ	LZ-1				
STORES	DECK STORE PAINT STORE VALVE REMOCON STATION	FLOOR	BARE STEEL	〃	〃	IZP	LZ	LZ-1	DP			
STORES	DECK STORE PAINT STORE VALVE REMOCON STATION	FLOOR	UNDER COVERING	〃	〃	IZP	"NO COATING"					
	SWIMMING POOL	OUTSIDE		〃	〃	IZP	CPP	CPP -1	CCP	CCP		
	SWIMMING POOL	INSIDE		〃	〃	IZP	CAC	CAC -1	CBT	CBT		
	PIPE DUCT SPACE			〃	〃	IZP	LZ	WRP	CP			
	ELECTRIC SPACE			〃	〃	IZP	LZ	WRP	CP			

PAINTING AREA				GRADE OF DE-RUSTING: BEFORE SHOP PRIMER	GRADE OF DE-RUSTING: BEFORE FIRST COATING	SHOP PRIMER	PAINT & NUMBER OF COAT: 1	2	3	4	5	REMARK
ENGINE ROOM AND STEERING GEAR ROOM	ENGINE ROOM BOILER ROOM STEERING GEAR ROOM EMERGENCY FIRE PUMP ROOM (INCLUDING STORES) CONTROL ROOM	CEILING	UNDER INSULATION	SP-10	SP-3	IZP	LZ	LZ-1				
			BARE STEEL	〃	〃	IZP	LZ	WRP	CP	CP		
		WALL PILLAR MACHINARY SEAT ETC.	UNDER INSULATION	〃	〃	IZP	LZ	LZ-1				
			CEILING ~SKIRTING	〃	〃	IZP	LZ	WRP	CP	CP		
			SKIRTING ~GRATING				LZ	WRP	CP	CP		
			GRATING~ TOP OF DOUBLE BOTTOM	〃	〃	IZP	BTE	BTE -1				
		FLOOR	TOP OF DOUBLE BOTTOM	〃	〃	IZP	BTE	BTE -1				
			GRATING: TOP				NO COATING					
			GRATING									
			GRATING: UNDER SURFACE		〃		LZ	WRP	CP	CP		EXCEPT BELOW
			GRATING: UNDER SURFACE		〃		BTE	BTE -1				MAIN FLOOR
			BILGE WELL	SP-10	〃	IZP	BTE	BTE -1				
			ENGINE FLAT	〃	〃	IZP	LZ	LZ-1	DP	DP		
			UNDER MACHINARY SEAT	〃	〃	IZP	BTE	BTE -1				

PAINTING AREA			GRADE OF DE-RUSTING		SHOP PRIMER	PAINT & NUMBER OF, COAT					REMARK
			BEFORE SHOP PRIMER	BEFORE FIRST COATING		1	2	3	4	5	
CARGO HOLD	CARGO HOLD AND WATER BALLAST	CEILING	SP-10	SP-10	IZP-1	IZS -1	IZS -2				
		WALL	〃	〃	IZP-1	IZS -1	IZS -2				
		TOP OF BOUBLE BOTTOM	〃	〃	IZP-1	IZS -1	IZS -2				
		BILGE WELL	〃	〃	IZP-1	IZS -1	IZS -2				
	CARGO HOLD (BULK)	CEILING	〃	SP-3	IZP	BTE	BTE -1				
		WALL	〃	〃	IZP	BTE	BTE -1				
		TOP OF DOUBLE BOTTOM				NO COATING					
		BILGE WELL	〃	〃	IZP	TE	TE-1				

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PAINTING AREA			GRADE OF DE-RUSTING: BEFORE SHOP PRIMER	GRADE OF DE-RUSTING: BEFORE FIRST COATING	SHOP PRIMER	PAINT & NUMBER OF COAT: 1	2	3	4	5	REMARK
TANKS AND OTHER	BALLAST TANKS	AFT PEAK TANK	SP-10	SP-3	IZP	TE	TE-1				
		FORE PEAK TANK	〃	〃	IZP	TE	TE-1				
		TOP SIDE TANK	〃	〃	IZP	TE	TE-1				
		WATER BALLAST TANK	〃	〃	IZP	TE	TE-1				
	L. O. TANKS	L. O. SUMP TANK IN D. B L. O. STORAGE TANK L. O. SETT. TANK CYLINDER OIL STOR. TANK	〃	〃	IZP	'WIPED WITH OIL'					
	F. O. TANKS	FUEL OIL TANK DIESEL OIL TANK F. O. SERVICE/SETT. TANKS D. O. SERVICE/SETT. TANKS	〃	〃	IZP	RPO	('RPO' SHALL BE COATED FOR HULL BLOCK ONLY)				
		F. O. SLUDGE TANK D. O. SLUDGE TANK BILGE TANK SEPAR. BILGE OIL TANK	〃	〃	IZP	TE	TE-1				
	FR. W. TANKS	FRESH WATER TANK COOLING F. W. EXPANSION TANK PURIFIER OPERATING WATER TANK	〃	〃	IZP	EP-1	EP-2	EP-3			
		PISTON COOLING F. W. TANK CASCADE TANK FUEL VALVE COOLING F. W. TANK	〃	〃	IZP-1	IZS-2					
	COFFEDAM, VOID SPACE		〃	〃	IZP	BTE	BTE-1				
	ECHO SOUNDING SPACE		〃	〃	IZP	BTE	BTE-1				